Dimensions of the heterosexual bond: Culture, personality and cycle effects

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Abstract

Romantic love, sexual desire, and adult attachment mechanisms were proposed to be universal adaptations which initiate and maintain a pair-bond relationship with a selected partner. The main goal of the thesis was to explore the functions of the pair-bond mechanisms from an evolutionary perspective and to test whether these proposed mechanisms showed the characteristics expected of psychological systems designed to initiate and maintain a pair-bond. The life history theory assumes that, as the available resources and lifespan are limited, decisions regarding resource allocation (e.g., energy) involve trade-offs among life history tasks (e.g., reproduction, parenting). The theory implies that individuals in different circumstances should deal with trade-offs differently, and this may be reflected in the experiences of pair-bond relationships. I first selected prospective items in order to construct self-report measurements of pair-bond relationships (Chapter Two). These items were administered to Occidental and Japanese participants. Their responses were entered in a series of factor analyses in order to confirm factor structure underlying pair-bond relationships, and to develop and refine measurements to assess relationships dimensions (Chapter Three). For both cultural groups, six factors were generated: a romantic love related factor (obsession); three attachment-related factors (care-receiving, care-giving, separation distress); and two sexual desire-related factors (partner- and other-directed sexual desire). The developed scales and/or some of the selected items were used to assess whether individuals differed in the intensity of relationship dimensions as a function of sex (Chapters Four and Five), age (Chapter Four), relationship stage (Chapter Four), cultural background (Chapter Four), personality (Chapter Five) and female conception probability (Chapter Six). Results showed that the intensity of relationship dimensions differed between sexes, different age groups, relationship stages, cultural backgrounds, personalities, and menstrual phases. In fact, culture had a major impact on pair-bond relationship dimensions. The strong cultural influence found on the relationship dimensions suggests that this should not be ignored by evolutionary psychologists.

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Table of Contents

List of Tables

Chapter Two

Chapter Three

Chapter Four

Chapter Five

Chapter Six

Appendix C

List of Figures

Chapter Four

Chapter Six

Declarations

All material presented in this thesis was produced between September 2010 and September 2014 at the Department of Psychology and Department of Anthropology, Durham University. The material presented herein has not been submitted previously, in part or in whole, at any other institution or for any other qualification. All work herein was carried out by myself (in conjunction with my supervisory team), with the exception of Chapter Five (The Effects of Sex and Personality) where the data used in the study was collected by the McCann Erickson company.

Statement of Copyright

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Chapter One
Introduction

Literature Review

For many years, the evolutionary and cross-cultural study of romantic love was neglected. It was even widely believed that romantic love was the product of Euro-American cultures based on assumptions that it was emergence associated with modernization and individualism (e.g., Stone, 1988). In 1992, however, Jankowiak and Fischer analysed 166 cultures from Murdock and White's (1969) Standard Cross-Cultural Samples and identified the existence of romantic love in 88.5% of cultures. They concluded that romantic love is a human universal or at least a 'near-universal'. If romantic love is a common feature of human nature, it may have evolved for particular functions. Evolutionary anthropologists and psychologists proposed that romantic love, together with sexual desire and adult attachment mechanisms, may aid, respectively, the initiation, establishment and maintenance of pair-bond relationships with selected partners (Buss, 2006; Fisher, 1998; Frank, 1988; Hirshleifer, 1987). This thesis focuses on sexual desire, romantic love, and adult attachment mechanisms in human romantic pair-bond relationships. The main goals are to explore the functions of these mechanisms from an evolutionary perspective in relation to sex, culture, and individual differences. In this chapter, I present the major theories and research on sexual desire, romantic love, and adult attachment.

Romantic Love, Sexual Desire, and Adult Attachment

Fisher (1998) proposed that mammals and bird species evolved *sexual desire*, *attraction* (or *romantic love* in humans), and *adult attachment* as three separate and sequential adaptive designs with different reproductive functions. Fisher hypothesized that 'sexual desire' motivates the desire for sexual union with a member of opposite sex, 'attraction (or romantic love)' leads one to focus one's mating effort on a preferred individual, and 'adult attachment' functions to maintain a pair-bond relationship long enough to fulfill species-typical parental duties. It was argued that each of three systems has specific (but some overlapping) neural circuits underlying different reproductive behaviours and emotions that may interact with each other.

Sexual desire. Sexual desire is directly associated with sexual intercourse, and its phylogenetic origin might be as deep as the origin of sexual reproduction (Eastwick, 2009). A set of sexual responses is regulated by sexual excitatory and inhibitory mechanisms, and adequate levels of sexual excitement and inhibition are adaptive in ensuring successful sexual intercourse (Bancroft & Janssen, 2000; Pfaus, 2009). The set of sexual responses involves attention to sexual cues and stimuli, activation of sexual

desire and arousal, and initiation or inhibition of sexual intercourse. Specifically, sexual cues and stimuli activate the sexual excitatory mechanism in the hypothalamus and limbic systems connected by the dopamine pathway. This involves the release of dopamine and melanocortins to induce sexual attention and desire, and noradrenaline and oxytocin to induce arousal. When a state of sexual satiety (e.g., an orgasm) is reached, activation of the sexual inhibitory mechanism occurs. This involves the activation of inhibitory opioid, endocannabinoid, and serotonin systems which attenuate the sexual excitatory mechanism for a period of time. Sexual reward serves to positively reinforce sexual intercourse ('liking') and enhance further desire for sexual intercourse ('wanting'). It also contributes to preferences for stimuli (e.g., a certain smell) associated with sexual satiety. Thus, sexual reward and satiety can activate the inhibitory mechanism temporarily while strengthening the future activation of the excitatory mechanism (reviewed in Pfaus, 2009).

In addition to the state of sexual satiety, the inhibitory mechanism can also be activated by contextual and environmental factors (e.g., sexual inhibition in order to avoid socially inappropriate sexual behaviours; Bancroft & Janssen, 2000). It is believed that the inhibitory mechanism is a part of executive functions which are mainly associated with the frontal lobes in mammalian brains (Pfaus, 2009). Executive functions are hypothesized to be a cluster of cognitive abilities associated with goal attainment. These abilities include *emotional* cognitive processes (e.g., regulation of instinctual behaviours) and *logical* cognitive processes (e.g., planning, abstract conceptualization, multitasking, sequential memory) (reviewed in Ardila, 2008; Chan, Shum, Toulopoulou, & Chen, 2008). Emotional executive functions may be common abilities shared by both human and non-human animals that have evolved to control and meet basic biological needs (e.g., food and sexual mates) (Ardila, 2008). Indeed, studies showed that non-human animals (e.g., chimpanzees; Beran, Savage-Rumbaugh, Pate, & Rumbaugh, 1999) could inhibit their impulse to take an immediate small amount of reward (i.e., food) in order to receive a larger amount of reward in the near future.

Logical executive functions (e.g., planning, abstract conceptualization, multitasking, sequential memory) might be specific to modern humans (*Homo sapiens*), who appeared about 200,000 years ago (McDougall, Brown, & Fleagle, 2005). Based on archaeological records, researchers suggested that archaic humans (e.g., *Homo neanderthalensis*) did not use logical executive functions (e.g., Coolidge & Wynn, 2001; Mithen, 1996). It seems that humans acquired many characteristics associated with logical executive functions during the Middle/Upper Paleolithic transition (at around 40,000-60,000 years ago) when humans showed a remarkable sudden change within archaeological records (Ardila, 2008; Coolidge &Wynn, 2001; Eastwick, 2009; Leary & Buttermore, 2003; Mithen, 1996). This archaeological evidence (see Leary & Buttermore, 2003) indicates that many characteristics of modern human cultures arose dramatically at

this period, and this sudden development of culture might have occurred in association with logical executive functions (Ardila, 2008).

Humans became able to conceptually represent themselves in the future, to anticipate the consequences of their behaviour and to inhibit impulsive action (e.g., Eastwick, 2009). Therefore, although non-human animals are also capable of inhibiting impulsive behaviours (e.g., Beran et al., 1999), the inhibition of desire may occur more often in humans, especially if acting upon that desire interferes with goal attainment or is socially unacceptable (Bancroft & Janssen, 2000; Pfaus, 2009). In this vein, although theorists have not reached agreement on the definition of sexual desire, many of them distinguish sexual desire from arousal (e.g., physiological genital arousal) and behaviour (e.g., Pfaus, 2009; Regan, 1996). While sexual desire can coincide with arousal and behaviour, the absence of sexual arousal and behaviour does not always imply a lack of desire, and sexual behaviour can also occur without sexual desire or arousal (Regan, 1996). Accordingly, I define 'sexual desire' as '*an internal state of willingness or motivation to have sexual intercourse with an individual to whom one is sexually attracted*'.

Attraction and romantic love. Fisher (1998) proposed that attraction (or romantic love in humans) facilitates mate choice by orienting sexual desire to a specific partner to form a pair-bond. Mate choice is inter sexual selection first proposed by Darwin(1871) and is characterized by any behaviour which restricts one's choice of potential mates (Halliday, 1983). It occurs when one sex non-randomly selects a mate of the opposite sex on the basis of specific traits they possess (Halliday, 1983; Kokko, Brooks, Jennions, & Morley, 2003).

Although mate choice for particular traits may occur without any evident benefit (e.g., by-products of natural selection on sensory architectures via pleiotropic effects; Kirkpatrick, 1987), mate choice can also directly or indirectly benefit individuals by enhancing their reproductive success (reviewed in Kuijper, Pen, & Weissing, 2012). Mate choice enhances individuals' fitness *directly* if preferred traits are associated with, for example, high fecundity or fertility (e.g., male sexual preference for relative youth; Buss, 1989) and greater parental care (e.g., plumage colour and parental care in northern cardinals; Linville, Breitwisch, & Schilling, 1998).

Mate choice also enhances individuals' fitness *indirectly* if preferred traits increase the physical attractiveness and genetic quality of their offspring. Producing offspring by mating with physically attractive mates can increase offspring fitness (hence indirectly enhancing fitness of parents), because physically attractive offspring are more likely to be chosen as mates in adulthood (Fisher, 1930). In addition, the good genes hypothesis argues that mate choice may be based on elaborate sexual ornaments (e.g., male peacocks' tails) which indicate an individual's good overall quality (Zahavi, 1975),

or a higher level of disease resistance (Hamilton & Zuk, 1982). This is because only a high-quality individual can afford to produce such costly ornaments without jeopardizing its survival. Individuals who choose mates with such indicator traits produce healthier offspring that are more likely to survive to sexual maturity.

However, traits may not always straightforwardly indicate genetic quality. They may signal, for instance, the degree of local adaptation (Proulx, 2001) or current disease resistance (Scott, Pound, Stephen, Clark, & Penton-Voak, 2010). Moreover, offspring genetic quality can be independent of parents' genetic quality due to interactions between paternal and maternal genes (Puurtinen, Ketola, & Kotiaho, 2009). Hence, individuals may also gain genetic benefits from choosing a genetically compatible partner to increase offspring quality (Puurtinen et al., 2009) or mating with different partners to produce greater genetic diversity in offspring (Jennions & Petrie, 2000; Zeh & Zeh, 2001).

Fisher (1998) hypothesized that human romantic love (or attraction in non-human animals) developed from these mate choice mechanisms. Similar to non-human animals, romantic love is characterized by sexual attraction focused on a preferred individual. Therefore, the mechanisms of romantic love and sexual desire might be closely related and interact with each other. Indeed, neural circuits for the two mechanisms show overlaps. For example, functional magnetic resonance imaging (fMRI) studies (reviewed in de Boer, van Buel, & Ter Horst, 2012; Zeki, 2007) reveal brain activation in the reward system including the hypothalamus in response to romantic love stimuli (e.g., photographs of a romantic partner). This reward system is thought to play an important role in facilitating sexual preference as well as partner preference (de Boer et al., 2012), and the hypothalamus is one of the key brain areas associated with sexual desire (Pfaus, 2009).

On the other hand, there are important differences between human romantic love and sexual desire (Fisher, Aron, & Brown, 2006). First, the goal of sexual desire is sexual union while it is emotional union in romantic love. Second, sexual desire can be experienced towards a number of individuals (without having romantic attraction towards them) while romantic love is usually directed to a particular individual. Third, sexual desire can be inhibited temporarily and frequently due to sexual satiety or social context. On the other hand, romantic love is unlikely to decrease in intensity by achieving emotional union and lasts for a longer period of time compared to sexual desire. These differences indicate that psychological factors play a crucial role in human romantic love (de Boer et al., 2012). Indeed, in humans, romantic love is associated with obsessive thoughts and intense desire for emotional unions with a selected partner (Fisher, 1998; Tennov, 1979). Based on previous studies and other researchers' conceptualisations, I define 'romantic love' as '*an intense desire for emotional union with and possessive feelings towards a particular individual*'.

Adult attachment. Fisher (1998) proposed that adult attachment evolved to maintain a pair-bond long enough to fulfill species-typical parental duties. Attachment refers to "an affectional tie that one person or animal forms between himself and another specific one" (Ainsworth & Bell, 1970, p. 50). The concept of attachment was initially developed for bonds between infants and caregivers (Bowlby, 1958). Attachment theory (Ainsworth, 1967; Bowlby, 1958, 1960a, 1960b, 1969, 1973, 1980, 1982) proposes that infants in various species (e.g., rhesus monkey: Harlow, 1958) have an instinctive attachment behavioural system leading them to attach to caregivers (i.e., attachment figures), while adults (e.g., parents) have an instinctive care-giving behavioural system motivating them to provide protection and support to infants. The main goal of the attachment and care-giving systems is the maintenance of proximity between infants and caregivers in order to protect infants from danger and to provision them. Regarding the infant attachment system, the key components are *proximity seeking*, *separation distress*, *safe haven*, and *secure base* (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1988). Strange situations or caregiver's absence causes anxiety or separation distress in infants, which in turn activates attachment behaviours (e.g., sucking, clinging, following, crying, and smiling) in order to re-establish proximity between infants and attachment figures. The attachment behaviours are deactivated once proximity with caregivers is established. This close bodily contact, but not the provision of food, enhances the development of infant-caregiver attachment bonds (Harlow, 1958). Once attachment bonds are developed, infants use caregivers as a safe haven to which they gain comfort and as a secure base from which to explore their environments (Ainsworth, 1967).

Attachment theory proposes that infants build an internal working model through interactions with caregivers, and this mental model continues to influence their social relationships in adulthood (Bowlby, 1969). Researchers further proposed that two romantically attracted adults form attachment bonds in the same manner as infants and caregivers (Hazan & Shaver, 1987). Nevertheless, the infant-caregiver attachment and adult attachment systems are not identical. The important difference is that, unlike attachment bonds between infants and caregivers, adult attachment bonds can be a two-way street (Hazan & Shaver, 1987; Weiss, 1982). That is, while infants are the unique receivers of care from their caregiver, there is no such fixed role in adult attachment relationships. In adult attachment relationships, one can play the role of both care-receiver and caregiver (Hazan & Shaver, 1994). Infants may seek proximity to caregivers to feel secure but not to give comfort to their caregivers, whereas adults may seek proximity to attachment figures to receive or/and give comfort (Hazan& Shaver, 1994).

In support of the hypothesis that the dynamics and functions of the attachment systems are similar in infant-caregiver and adult-adult contexts, an fMRI study (Zeki, 2007) found overlaps in patterns of activation (striatum) and deactivation (frontal cortex)

induced by maternal love stimuli and romantic love stimuli (i.e., photographs of one's own children and romantic partners, respectively). On the other hand, the hypothalamus, which is closely linked to sexual desire and romantic love, did not show activation in response to the maternal love stimuli.

Romantic love and adult attachment are not isomorphic. Adult attachment bonds can be seen in various types of relationships other than romantic ones, for instance, in friendship (Hazan & Zeifman, 1994). Thus, adult attachment bonds are unlikely to be unique to romantic relationships. In line with Fisher's hypothesis (1998), I distinguish adult attachment from romantic love and define it as '*an affectional bond between two individuals maintained through mutual care-receiving and care-giving behaviours, involving separation distress and proximity seeking behaviours*'.

The Evolution of Human Pair-Bond Relationships

Sexual desire, romantic love, and adult attachment mechanisms in humans are argued to function as the initiators and maintainers of pair-bond relationships (Fisher, 1998). It was hypothesized that these pair-bond mechanisms evolved to increase offspring survival by underpinning both maternal and paternal care, because human infants need extended and intensive care due to their large and energetically expensive brains and extended neoteny (e.g., Eastwick, 2009; Fisher, 1989; Lovejoy, 1981). Humans, compared to other species, have the highest encephalization quotient (measured as the degree to which a species' brain size deviates from the expected brain size in relation to a reference species; Jerison, 1973) and the largest number of cortical neurons (Roth & Dicke, 2005). Increased neural inter connectivity might also have contributed to making human cognitive abilities distinguishable from other species (Barton & Venditti, 2013). The larger and energetically expensive human brain is supported by high-calorie and nutrient-dense foods (Leonard, Snodgrass, & Robertson, 2007). In addition, relative to non-human primates, physical and behavioural development and reproductive maturity are much delayed in humans (Bjorklund, 1997). This implies that human child-rearing requires the provision of calorie- and nutrient-rich foods and extensive parental care for a prolonged period of time.

Comparative and phylogenetic analyses of mammalian species suggest that the association between extended neoteny and pair-bonding may be due to the existence of shared ancestry. Fraley, Brumbaugh, and Marks (2005) argued that paternal care evolved prior to pair-bond mechanisms and might have led to the evolution of pair-bonding. Traditionally, the asymmetry in reproductive costs between the sexes is thought to produce conventional sex roles such as choosy females and competitive males (will be discussed in 'Life history theory' section). Compared to women, men are expected to gain relatively more from multiple matings than from maintaining pair-bond relationships

due to their lower reproductive costs (e.g., Buss & Schmitt, 1993). However, if paternal care (supporting a child and/or a child's mother) became important for offspring survival, it might have led men to maintain pair-bond relationships (Fraley et al., 2005). For example, studies in nonindustrial human societies show that male provisioning plays an important role in successful child rearing especially during the mother's lactation period (Quinlan &Quinlan, 2007). However, given the fact that parental care increases offspring fitness conditionally but not absolutely, paternal care may not be obligate for offspring survival (Geary, 1998; Sear & Mace, 2008).

There are alternative explanations for the evolution of pair-bonding. It may have evolved for protection of infants from conspecific males (Dunbar & van Schaik, 1990) or food guarding (Wrangham, Jones, Laden, Pilbeam, & Conklin-Brittain, 1999). In addition, it has been suggested that concealed ovulation in women motivated men to be continually sexually attracted to a particular partner (Marlowe & Berbesque, 2012) in order to guard their mate and improve paternal certainty (Chapais, 2008). This implies that paternal care was the result of antagonistic coevolution of female and male reproductive strategies (Geary, 1998). It is likely that multiple factors were involved in the evolution of pair-bonding (Eastwick, 2009). However, the aim of the current thesis is not to identify selective pressures which might have shaped pair-bonding or to test associated hypotheses. Instead, I focus on Fisher's hypothesis (that pair-bond mechanisms evolved to initiate and maintain relationships between men and women for successful child rearing) and test whether these mechanisms show the expected design characteristics.

It has to be noted that, of course, pair-bond relationships operated by sexual desire, romantic love, and attachment mechanisms could be formed between opposite-sex individuals and between same-sex individuals. One of the differences between opposite- and same-sex behaviours is that the former could result in reproduction while the latter does not. If organisms attain reproductive success by producing offspring, it is puzzling how same-sex behaviours have evolved. Nonetheless, same-sex behaviours is widespread in many species, including humans (reviewed in Bailey & Zuk, 2009; Kirkpatrick, 2000). A growing body of research has tried to tackle this Darwinian paradox of same-sex behaviours and have provided various explanations (e.g., in humans, genetic factors promoting male homosexuality enhance female fecundity, and therefore are maintained by selection; Camperio-Ciani, Corna, & Capiluppi, 2004). As noted earlier, it is likely that multiple factors were involved in the evolution of pair-bonding. However, an examination of every possible explanation for the evolution of pair-bonding is beyond the scope of this thesis. The aim of the current thesis is to examine Fisher's hypothesis, which especially focuses on reproductive benefits of pair-bond relationships.

Therefore, throughout the thesis, I focused on pair-bonding between heterosexual identified individuals.

The Definition of 'Pair-Bond'

Throughout this thesis, I focus on human romantic relationships and the term 'pair-bond' is used to refer to '*a bond with a preferred individual that is initiated and maintained by sexual desire, romantic love, and attachment mechanisms*'.

Pair-bond and sexual monogamy. To avoid conceptual confusion, I distinguish 'pair-bond' (or social monogamy) from sexual monogamy. For example, although above 90% of bird species are estimated to be socially monogamous (Lack, 1968), they are rarely sexually monogamous (i.e., an exclusive pair-bond without extra-pair partners). In fact, only around 25% of these socially monogamous bird species are thought to be sexually monogamous, and approximately 11% of offspring in socially monogamous bird species are estimated to be the result of extra-pair copulation (Griffith, Owens, & Thuman, 2008). The data indicate that most bird species simultaneously engage in social monogamy and extra-pair copulations.

In humans also, sexual strategies theory proposes that both sexes have evolved a combination of distinct *long-* and *short-term* mating strategies (Buss & Schmitt, 1993). Note that the term 'strategies' in this context is used to refer to suites of goal-directed and problem-solving mating behaviours that are not necessarily conscious. Sexual strategies theory views mating as a temporal continuum with long-term relationships (e.g., marriage) at the one end, short-term relationships (e.g., one-night stands, brief affairs) at the other end, and relationships of intermediate duration at the mid-point of this dimension. It is proposed that long- and short-term mating strategies address different adaptive problems. For example, short-term mating strategies may focus on increasing access to a number of fertile or high-quality sexual partners, and long-term mating strategies may focus on acquiring extended resource provision and parental care for offspring. This implies that while some pair-bonded individuals may stay sexually monogamous, others may engage in uncommitted sexual relationships outside the existing pair-bond relationships.

Consideration of long- versus short-term mating strategies has been one of the central topics in evolutionary psychology; however, there is conceptual ambiguity in the distinction between these two strategies (Eastwick, 2009). First, it is difficult to ascertain how each individual subjectively perceives the duration of relationships (Eastwick, 2009). A relationship of several months might be 'long' for some individuals, while it could be 'brief affair' for others. Second, the temporal duration of a relationship is a separate issue from the emotional involvement of a relationship (Miller & Fishkin, 1997). Relationship length does not guarantee that there is an intimate bond between couples. For example,

one might engage in a sexual relationship with a particular partner for a long period of time in order to receive material resources.

In this thesis, the term 'pair-bond' refers to a heterosexual attachment bond involving mutual romantic and sexual attraction, but it is not necessarily limited to a sexually exclusive relationship nor is it defined by relationship length. I use the term 'long-term relationship' to refer to pair-bonded relationships, and 'short-term relationship' to refer to sexual intercourse outside the pair-bond or any form of uncommitted sexual relationship.

Pair-bond and marital monogamy. There is some conceptual confusion in the use of term 'monogamy' (Low, 2003). In the present thesis, I distinguish 'pair-bond' from marital monogamy. This is because a marriage system is a social and cultural institution controlled by rules in a particular society (Low, 2003), and marital forms do not necessarily entail the existence of intimacy between couples (Draper & Harpending, 1988; Dunbar, 2012; Eastwick, 2009; Miller & Fishkin, 1997). For instance, monogamous marriage may occur between romantically-attracted individuals, whereas marriage in any form (e.g., monogamy, polygyny) could also occur without involving romantic attraction between couples (e.g., arranged marriage). Therefore, I do not use the term 'pair-bond' as synonymous with 'marital monogamy'.

Life History Theory

Sexual desire, romantic love, and adult attachment have been suggested to be common mechanisms shared by all humans (Fisher, 1998), but how each individual deploys these mechanisms may differs. Within an evolutionary perspective, life history theory (reviewed in Kaplan & Gangestad, 2005) is an important framework for the study of individual differences (Penke, 2010). The theory assumes that organisms need to obtain resources (e.g., energy, time, and money) from their environment and allocate these resources to various life history tasks (e.g., successful growth and mating). Since the available resources and lifespan of each organism are finite, acquisition and allocation of resources to each life history task needs to be efficient and effective, and such allocation decisions often involve trade-offs between life history tasks. A major trade-off is between *survival* and *reproductive* effort. For example, energy spent on traits that increase mating frequency (reproduction) may lower immune resistance (survival). It has been suggested that reproductive effort involves a further trade-off between *mating* effort and *parental* effort; the allocation of resources to obtain sexual partners versus the allocation of resources to produce and raise offspring and other kin (Low, 1978). Individuals need to make 'decisions' (either consciously or unconsciously) involving these trade-offs in order to maximize their fitness within prevailing circumstances (e.g.,

sex, environmental, and individual conditions), thus leading to phenotypic variations in life history strategies.

Sex differences. Sex differences have been one of the central topics in evolutionary psychology and anthropology. Darwin (1871) observed that generally females are choosy about mates and expend greater parental care than males, whereas males compete more severely for mating access than females do. Traditionally, the asymmetry in potential reproductive rates and *minimal* parental investment between the sexes is thought to produce conventional sex roles (i.e., choosy females and competitive males). If females' potential reproductive rate is slower than that of males, females will be choosy while males will be competitive (Clutton-Brock & Vincent, 1991). Bateman (1948) suggested that the minimal reproductive cost is higher in females than males because egg production is more energetically costly than sperm production. This anisogamy suggests that male reproductive success depends on insemination whereas female reproductive success depends on egg and offspring production, and variance in reproductive success (number of mates and offspring) is greater in males than females.

Trivers (1972) expanded Bateman's principle and proposed parental investment theory, in which parental investment was defined as "*any investment by the parent in an individual offspring that increases the offspring's chance of surviving (and hence reproductive success) at the cost of the parent's ability to invest in other offspring*" (p. 139). Informed by life history framework, the theory argues that parents face a trade-off between investing resources in *current* offspring and *future* offspring as individuals' resources and lifespan are limited. Moreover, the asymmetry in minimal parental investment between the sexes leads them to resolve this trade-off differently. According to the theory, a female is less likely to terminate her parental investment after offspring birth, because replacement costs are high (Dawkins & Carlisle, 1976; but see Kokko & Jennions, 2008). Because a male's initial parental investment is smaller than that of a female, he can maximize his reproductive success by multiple copulation with many females. Furthermore, he can terminate his investment soon after fertilization in order to return to the mating pool immediately. Consequently, the operational sex ratio (OSR: the ratio of receptive males to receptive females at any given time; Emlen & Oring, 1977) will be male-biased and the surplus of males will compete for mating access to females. The theory further predicts that males should provide less parental care for offspring after birth, because they need to expend more resources on competitive traits.

This male-biased competitiveness and promiscuity, and female-biased parental care and choosiness have been a main focus of sexual selection (Edward & Chapman, 2011). However, recent theoretical developments have reconsidered and challenged the assumptions underlying conventional sex roles. One of the key assumptions of the conventional sex role argument is that male reproductive success increases with number

of inseminations, and that variance in reproductive success is greater in males than females. However, this pattern is not universal either between or within species. For example, in some mammals, females provide more care for offspring than males yet compete more fiercely with other females than males, and variance in lifetime reproductive success is greater in females than males (e.g., wild meerkats; Clutton-Brock et al., 2006). In humans, there are considerable between-population differences in the ratio of male-to-female variance in reproductive success, with monogamous societies showing a lower ratio than polygynous societies (Brown, Laland, & Mulder, 2009). Second, the conventional sex role argument assumes that there is a positive association between past and future parental investment in females; however, past investment should be unrelated to future investment (Kokko & Jennions, 2008). Third, the conventional sex role view assumes that males face a trade-off between mating and parental effort. Nonetheless, in some species males use parental effort as a mating strategy and invest heavily in both parental care and competition for mates (e.g., sand gobies; Pampoulie, Lindstrom, & St Mary, 2004). This implies that male's tendency to allocate more to mating than parental efforts may not be distinctive as predicted by the classic view (Stiver & Alonzo, 2009).

Furthermore, recent theoretical developments suggest that potential reproductive rates, the amount of parental investment, and OSR are not sufficient to predict the relative choosiness and competitiveness of the two sexes (Kokko & Jennions, 2008; Kokko & Monaghan, 2001). In fact, choosiness and competitiveness may be determined by various factors, such as sex-specific breeding and mortality costs, and mate quality (Kokko & Monaghan, 2001). For example, male parental care can evolve in a male-biased OSR, if the probability of gaining mates is lower due to increased male-male competition or one's own mate quality (Kokko & Jennions, 2008). Male choosiness can also evolve in female-biased OSR if there is a variation in female mate quality and the benefits of choosiness outweigh the cost (Edward & Chapman, 2011). Under this condition, female-female-competition may evolve as well. Furthermore, a considerable body of research suggests that females can obtain benefits through multiple mating with different mates. For instance, females who copulate repeatedly with different males can gain high quality sperm that succeed in competition against sperm of different males (Parker & Pizzari, 2010), produce diversity in genetic combinations of offspring (Jennions & Petrie, 2000; Zeh & Zeh, 2001), or gain material benefits from mates (Thornhill & Gangestad, 2008). These recent theoretical developments indicate that sex role divergence may not be as marked or predictable as the classic model argues (Kokko & Jennions, 2008).

However, these challenges do not wholly invalidate the conventional sex role view. Indeed, as the conventional sex role argument anticipates, a considerable body of data indicates that men have evolved a higher sex drive and prefer a larger number of

sexual partners than women (Baumeister, Catanese, & Vohs, 2001). It is difficult to consider all the factors that may contribute to sex role divergence in humans, especially when samples are composed of participants with various cultural and demographic backgrounds. Hence, in this thesis, I test sex differences in mechanisms underlying pair-bond relationships (i.e., sexual desire, romantic love, and adult attachment) from abroad conventional sex role perspective and examine the extent to which sex roles diverge within the samples studied.

Individual differences. The mechanisms underlying pair-bond relationships are suggested to be universal (Fisher, 1998; Jankowiak & Fischer, 1992). When physical and social environments remain stable over long evolutionary periods, organisms evolve 'universal adaptations' which go to fixation in the population (Penke, 2009). However, the expression of these adaptations can have different settings as a function of sex, life history stage, or local conditions (Tooby & Cosmides, 1990). The conventional sex role view predicts that some sex differences in motivations and behaviours produced by the pair-bond mechanisms may be universal since biological differences between the sexes have been stable and consistent (Penke, 2010; Schmitt, 2003). In addition, when the environment relevant to a specific trait is less stable and more heterogeneous, organisms may evolve the ability to adaptively modify their phenotypes in response to the fluctuating environment (phenotypic plasticity; Hollander, 2008). Phenotypic plasticity itself is a universal design which is sensitive to environmental cues (Penke, 2010), and forms of phenotypic plasticity may include adaptive developmental plasticity and adaptive conditional adjustment (Penke, 2009). In adaptive developmental plasticity, individuals may adjust their *future* life history strategies based on early childhood experiences (Penke, 2010). Regarding the pair-bond mechanisms, unstable and stressful childhood environments may cause individuals to anticipate instability in their reproductive environment, and consequently adopt a short-term mating strategy (e.g., Belsky, Steinberg, & Draper, 1991; Chisholm, 1996; Del Giudice, 2009; Ellis, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1999). In adaptive conditional adjustment, individuals may react to their *current* environmental context to adjust their *current* life history strategies (Penke, 2010). For example, individuals may modify their mating strategies depending on conditions such as the number of potential mates, mate values, influences of kin, and cultural norms (e.g., Buss & Schmitt, 1993; Buss, 1994; Gangestad & Simpson, 2000). Under conditional adjustment, developmental phenotypic alteration is unnecessary; individuals can adjust their life history strategies faster and more flexibly than through developmental plasticity (Penke, 2009). This implies that, although the pair-bond relationship mechanisms may be a human universal, the expression of these mechanisms may differ as a function of sex, culture, and individual differences.

Cultural differences. As mentioned above, cultural factors may influence how individuals experience pair-bond relationships. If logical executive functions are associated with the pair-bond mechanisms (e.g., Eastwick, 2009; Pfaus, 2009), and logical executive functions evolved in association with cultures (Ardila, 2008), culture may be one of the significant factors to affect the expression of pair-bond mechanisms (e.g., Fisher, 1998; Pfaus, Kippin, & Centeno, 2001). Culture may be defined as "information capable of affecting individuals' behavior that they acquire from other members of their species through teaching, imitation, and other forms of social transmission" (Boyd & Richerson, 2005, p. 5). Researchers have suggested that human culture may evolve in the same manner as the process of biological evolution resulting in the differential transmission of cultural variants (reviewed in Mesoudi, 2009). Similar to genetic transmission, a cultural variant (i.e., a unit of cultural transmission) may be transmitted vertically from parents to offspring (Cavalli-Sforza & Feldman, 1981). However, unlike gene transmission, cultural transmission may occur horizontally from peer to peer and obliquely from elder to younger or vice versa (Cavalli-Sforza & Feldman, 1981). Moreover, cultural transmission is not limited to a 'one-to-one' form as in genetic transmission, but it can be 'one-to-many' or 'many-to-one' (Shennan, 2002). The transmission of cultural variants is also considerably faster, with the rate of transmission increasing exponentially with the advent of electronic media (Barkow, O'Gorman, & Rendell, 2012).

Cultural transmission involves various processes which may change the frequency of a cultural variant in a population across time (Mesoudi, 2009). For instance, in cultural mutation, variation produced by misremembering or transmission errors can change cultural variants over time (Boyd & Richerson, 1985). In cultural drift, the frequency of a cultural variant in a population changes over time based on random sampling (Bentley, Hahn, & Shennan, 2004). In guided variation, individuals adopt and modify a cultural variant on the basis of their individual experiences (Boyd & Richerson, 1985). Natural selection may also be responsible for change in the frequency of a cultural variant if the variant is associated with individuals' survival and reproduction (e.g., reduction of tabacco use due to its negative impact on survival; Cavalli-Sforza & Feldman, 1981).

Moreover, if individuals have a choice between cultural variants, one may be more likely to be chosen than another. In such a case, individuals' decisions may be influenced by various types of biases (Boyd & Richerson, 1985). For example, in conformist transmission, individuals adopt the cultural variant of the majority (Laland & Brown, 2002). In prestige bias, individuals select to copy individuals who have achieved success or prominence (Boyd & Richerson, 1985). In addition to distribution-based transmission biases, individuals adopt the cultural variant since its content itself is

attractive (Claidière & Sperber, 2007). These biases may enhance individuals' own reproductive success and survival probabilities (Durham, 1991; Laland & Brown, 2002), but both can result in the adoption of behaviours and beliefs that are maladaptive in terms of Darwinian fitness (Henrich, 2004; Shennan, 2002). Thus, cultural fitness must be distinguished from Darwinian fitness (Cavalli-Sforza & Feldman, 1981).

In this thesis, I examined whether culture affects the structure of pair-bond relationship dimensions, and whether there are significant differences between Occidental (composed of English-speaking and European countries) and Japanese samples. Given the fact that most theories and hypotheses about pair-bond mechanisms were developed and tested in Western cultural groups, it was of interest to see how well they applied to non-Western cultures. Comparisons between the Occidental and the Japanese groups were made using the framework of Hofstede's (1980) cultural dimension theory. On the basis of a factorial study on a large cross-national database, Hofstede proposed that societies could be positioned on six dimensions, such as 'power distance' (level of inequality), 'uncertainty avoidance' (level of tolerance for ambiguity), 'individualism versus collectivism' (intensity of ties between individuals in groups), 'masculinity versus femininity' (the degree of gender differentiation in social roles), 'long-term versus short-term orientation' (variations in the understanding and use of time), and 'indulgence versus restraint' (level of control over basic human needs associated with enjoyment of life) (Hofstede & Bond, 1988; Hofstede, Hofstede, & Minkov, 2010; Hofstede, 1980; Minkov, 2007). The mean scores of a country on each of these dimensions "do not provide *absolute* country positions, but only their positions *relative* to other countries in the set" (Hofstede, 2001, p. 36). Thus, this dimensional model attempts to describe differences in 'values' ("broad tendencies to prefer certain states of affairs over others"; Hofstede, 1991, p. 263) at the national rather than the individual level (Hofstede, 1980, 2011). The present study will focus on the dimensions of *individualism-collectivism* and *masculinity-femininity*. The individualism-collectivism dimension describes a society-level characteristic of the extent to which its members are psychologically integrated into a group. The masculinity-femininity dimension describes the extent to which a society is masculine (e.g., assertive) or feminine (i.e., modest) (Hofstede, 1998). Comparisons among 76 countries showed that individualism was more dominant in developed and Western countries, while Japan was placed at the mid-point of the individualism-collectivism continuum. Japan (in addition to German speaking countries, and some Latin countries) was characterized by higher masculinity than was found in English-speaking Western countries (Hofstede et al., 2010). This implies that, relative to the Occidental group, the Japanese group is expected to be more collectivistic and masculine. Based on this, the present thesis will examine whether these dimensions help to explain

differences between the Japanese and the Occidental groups in the experiences of pair-bond relationships.

Overview of the Thesis

The main goals of the thesis were to explore the functions of the pair-bond mechanisms from an evolutionary perspective and to test whether these proposed mechanisms showed the characteristics expected of psychological systems designed to initiate and maintain a pair-bond between men and women. In order to test predictions, I first selected prospective items (Chapter Two) and refined scales to measure the dimensions of pair-bond relationships (Chapter Three). Using these scales, I tested whether individuals differed in the expressions of pair-bond relationship dimensions as a function of demographic and cultural background (Chapter Four), and personality (Chapter Five). Lastly, I examined whether women showed different patterns in the expression of relationship dimensions across their menstrual cycles (Chapter Six). In Chapter Seven, I give an overview and discussion of the thesis (Chapter Seven).

Chapter Two
Item Selection

In the previous chapter (Chapter One), the dimensions of pair-bond relationships were identified (romantic love, adult attachment, and sexual desire) and defined. In order to explore the functions of the pair-bond mechanisms and to test predictions relative to these mechanisms, appropriate measurements were required. The goal of the work reported in this chapter was to select prospective items in order to construct a self-administered questionnaire. This questionnaire was used to assess the intensity of each relationship dimension. In the next study (Chapter Three), these selected items were entered in factor analyses in order to test whether the relationship dimensions would conform to the conceptual distinctions made by Fisher (1998) and attachment theory (e.g., Bowlby, 1969), and to refine measurement items for each factor. For this reason, the present chapter selects a rather large number of items for each hypothesized relationship dimension. This chapter first provides a short historical overview of romantic love studies. This will emphasize the need for the new measurement which is integral to the current thesis. Then it presents the items selected to assess each of the pair-bond relationship dimensions.

A Review of Romantic Love Study

Romantic relationships were not studied as a topic in their own right until about forty years ago (reviewed in Berscheid, 2010; Rubin, 1970). In the mid-twentieth century, when interpersonal attraction (i.e., 'liking': Lindzey & Byrne, 1968) became a major object of interests by social psychologists, romantic love finally began to attract attention. However, at that time romantic love was not formulated as an independent concept. Rather, it was treated as an intense form of liking (e.g., Heider, 1958). Psychologists were chiefly interested in how one person would be attracted to another and examined in the circumstances in which one person expresses liking and a wish to interact with another. Although liking and romantic love were considered to be different only quantitatively, rather than qualitatively, some researchers started to question this conception (e.g., Berscheid & Hatfield, 1978; Rubin, 1970). For instance, Rubin (1970) constructed a Love scale and a Liking scale and showed that the two scales were only moderately associated, indicating that romantic love and liking were qualitatively different. Although it was later suggested that Rubin's Liking and Love scales might be addressing familial and friendship types of love (e.g., Acker & Davis, 1992; Fehr, 1994), his separation of romantic love from liking had strong influences on subsequent love studies (Masuda, 2003).

Romantic love was separated from liking and finally started to be conceptualized as a separate concept (Rubin, 1970). Nevertheless, scholars have not yet reached a consensus on how to define romantic love, and which taxonomies to use. For instance, the term romantic love has been used with different definitions, such as "love between unmarried opposite-sex peers, of the sort which could possibly lead to marriage" (Rubin, 1970, p. 266); "any intense attraction that involves the idealization of the other, within an erotic context, with the expectation of enduring for some time into the future" (Jankowiak & Fischer, 1992, p.150); and "liking with an added element, namely, the arousal brought about by physical attraction and its concomitants" (Sternberg, 1986, p.124). In these definitions of the term 'romantic love' there is conceptual overlap, but there are also differences. Rubin's definition of romantic love specifies a relationship status, but Jankowiak and Fischer's and Sternberg's definitions do not. Rubin's and Jankowiak and Fischer's definitions include an expectation of the future, while Sternberg's focuses on explaining the nature of romantic love. Different terms have also been used to refer to similar notions of romantic love. For example, *limerence* (Tennov, 1979) and *passionate love* (Hatfield & Walster, 1978; Hatfield & Rapson, 1993) describe romantic experiences as cognitive and emotional events involving an intrusive thinking about the beloved, idealization of the beloved's positive characteristics, physical reactions (e.g., flushing, trembling), a desire for emotional and sexual union with the beloved, and a fear of rejection by the beloved.

Inconsistency in terminologies and definitions might indicate that the state of being in love cannot be described in a single component but rather requires multiple components (e.g., cognitive, behavioural, physiological). Indeed, researchers have developed various self-administered measurements to assess different components of love. One such measurements is (Robert J. Sternberg, 1997)'s Triangular Love Scale (TLS), which was constructed based on his triangular theory of love (Robert J. Sternberg, 1986). The theory proposes three components of love: *Intimacy* ("feelings of closeness, connectedness, and bondedness"), *Passion* ("the drives that lead to romance, physical attraction, sexual consummation"), and *Decision/Commitment* ("the decision that one loves someone" and "the commitment to maintain that love") (Sternberg, 1986, p. 119). The intimacy and decision/commitment components are proposed to appear in various close relationships (e.g., romantic, familial, and peer relationships), whereas the passion component is mainly restricted to romantic relationships. It was proposed that various combination of these components determine the type of relationship (e.g., romantic love derives from a combination of intimacy and passion; Sternberg, 1997), and the degree of each of the three components differs indifferent types of relationships (e.g., commitment may be higher in maternal or paternal love but relatively lower in friendship; Sternberg, 1997). Another influential measure of romantic relationships is Hendrick and Hendrick

(1986)'s Love Attitudes Scale. It was constructed with six sub-scales to assess Lee (1973)'s six love styles. Lee proposed three major romantic love styles, *Eros* (love with an intense physical and emotional attraction), *Ludus* (love played as a game and lacking emotional commitment), and *Storge* (friendship love based on affection), and three secondary styles, *Mania* (possessive and obsessive love), *Pragma* (practical and realistic love) and *Agape* (altruistic and selfless love). Although LAS was originally developed to measure attitudes towards romantic relationships, it was pointed out that LAS may assess the configuration of love attitudes relevant to a specific relationship rather than an individual's love style (Davies, Kirkpatrick, Levy, & O'Hearn, 1994). The two scales described above may measure components of love and create a typology of love relationships. On the other hand, Hatfield and Sprecher (1986) developed a Passionate Love Scale (PLS) in order to measure the intensity of romantic experiences. PLS aims to measure Hatfield and Walster (1978)'s definition of *passionate love*, and its items address cognitive components (e.g., intrusive thinking), emotional components (e.g., longing for reciprocity), and behavioural components (e.g., services to partners). Recently, Langeslag, Muris, and Franken (2013) developed Infatuation and Attachment Scales (IAS). IAS aims to measure levels of *Infatuation* ("the overwhelming, amorous feeling for that one special person") and *Attachment* ("the comforting feeling of emotional bonding with another individual") in a romantic context (Langeslag, Muris, & Franken, 2013, p. 739). The items for infatuations were especially designed to reflect the early stage of romantic relationships whereas attachment items were focused on more stable relationships. Their factor analytic study supported these two aspects of romantic love, where infatuation and attachment items loading on two separate factors.

The TLS, LAS, PLS, and IAS were shown to have acceptable reliability and validity in their original studies as well as in subsequent studies (e.g., Graham & Christiansen, 2009). However, for the current study, it was necessary to construct a specific set of measures. First, the aim of this thesis was not to identify types or categories of love but to assess the intensity of each relationship dimension (romantic love, adult attachment, sexual desire). Thus, scales which focus on assessing types of love or attitudes to love were not suitable (e.g., LAS). Furthermore, one of the key aims of this thesis was to measure each of the pair-bond relationship dimensions separately. However, most existing scales integrate romantic love, adult attachment, and sexual desire components into the same dimension. For instance, emotional and sexual attractions are integrated into a single component such as *Passion* in TLS and *Eros* in LAS. PLS also contains several items referring to sexual attraction, but these are not treated as an independent dimension. IAS may be a good candidate since it clearly distinguishes romantic love (infatuation) and attachment components. However, infatuation items were designed to measure the early stage of romantic love, and these

infatuation items are mostly focused on physiological reactions (e.g., “get shaky knees”, “reduce my appetite”, “get clammy hands”, “become tense”; Langeslag, Muris, & Franken, 2013, p. 742) rather than emotional aspects, which may not be applicable for older individuals in relationships at later stages. Thus, separate scales for each relationship dimension were required.

Item Selection

For the next step, items were selected to reflect the definitions of each relationship dimension (romantic love, adult attachment, sexual desire). Two criteria were used to select or create candidate items for inclusion in the relationship dimension scales. First, an existing scale was used if it was developed based on samples including both sexes, it did not address a specific group (e.g., romantic love in women with depression), and if it fitted the definition of relationship dimensions used in the present study. Second, new items were developed if there was no existing scale which matched the definitions of relationship dimensions used in the present study.

Romantic Love

In Chapter One, romantic love was defined as ‘an intense desire for emotional union with and possessive feelings towards a particular individual’. This definition of romantic love is very similar to ‘passionate love’ which can be assessed by PLS (Hatfield & Sprecher, 1986). Passionate love in PLS was defined in the following way (Hatfield &Walster, 1978, p.9) [sic]:

> “...a state of intense longing for union with another. Reciprocated love (union with the other) is associated with fulfilment and ecstasy. Unrequited love (separation) with emptiness; with anxiety or despair. A state of profound physiological arousal.”

PLS was developed using a sample of male and female undergraduate students. This meant that PLS was a suitable measure of romantic love in the present study; thus, the scale was chosen as a potential romantic love scale. A full version of PLS contains 30 items, and a short version includes 15 items. To keep the questionnaire short, the short version was used.

Table 1 presents the 15 items for the short version PLS. The original PLS used underscores (i.e., ____) to refer to a partner, but this was replaced by ‘my partner’ in the present study. The short version PLS contains items that reflect intrusive thinking, idealization of partners, desire to know partners and be known, attraction towards partners, negative feelings when things do not go well, longing for reciprocity, desire for

complete union, physiological arousal, actions toward determining partners' feelings, and services to partners. As mentioned earlier, some of the items may reflect sexual attraction (e.g., I sense my body responding when my partner touches me) and attachment components (e.g., I would feel despair if my partner left me). It was anticipated that these items might load on sexual desire or attachment components when they were entered in the subsequent factor analyses (Chapter Three).

Table 1

Items for Romantic Love

Sub-dimension	Item
Intrusive thinking or preoccupation with the partner	- Sometimes I feel I can't control my thoughts; they are obsessively on my partner. - My partner always seems to be on my mind.
Idealization of the partner or of the relationship	- I would rather be with my partner than anyone else. For me, my partner is the perfect romantic partner.
Desire to know the partner and be known	- I yearn to know all about my partner. - I want my partner to know me - my thoughts, my fears, and my hopes.
Attraction to the partner, especially sexual attraction	- I possess a powerful attraction for my partner.
Negative feelings when things go awry	- I would feel despair if my partner left me. - I'd get jealous if I thought my partner was falling in love with someone else. - I get extremely depressed when things don't go right in my relationship with my partner.
Longing for reciprocity	- I have an endless appetite for affection from my partner.
Desire for complete union	- I want my partner-physically, emotionally, mentally.
Physiological arousal	- I sense my body responding when my partner touches me.
Action toward determining the partner's feelings	- I eagerly look for signs indicating my partner's desire for me.
Services to the partner	- I feel happy when I am doing something to make my partner happy.

Adult Attachment

In Chapter One, adult attachment was defined as 'an affectional bond between two individuals maintained through mutual care-receiving and care-giving behaviours, involving separation distress and proximity seeking behaviours'. Attachment theory (Ainsworth, 1967; Bowlby, 1958, 1960a, 1960b, 1969, 1973, 1980, 1982) proposes that infants' attachment system leads them to attach to caregivers, while adults' care-giving system motivates them to provide care for infants. According to the theory, the key components of the attachment system are *proximity seeking*, *separation distress*, *safe haven*, and *secure base* (Ainsworth et al., 1978; Bowlby, 1988). The attachment and care-giving systems function to maintain proximity between infants and caregivers in order to protect infants from danger and to provision them. When infants encounter strange or anxious situations (e.g., separation from caregivers), attachment behaviours (e.g., crying) are activated. Care-giving behaviours are activated in response to infants' attachment behaviours, and proximity with infants is re-established. This, in turn, deactivates attachment behaviours. This scenario was described as infants using caregivers as a safe haven from which they gain comfort (Ainsworth, 1967). Proximity seeking declines when infants start to crawl and move around. Once infants develop secure attachment bonds with caregivers, maintaining constant proximity is not necessary. Infants are able to explore their surroundings, because they know their caregivers are available if needed. This scenario was described as infants using caregivers as a secure base (Ainsworth, 1967). In infant-caregiver attachment bonds, infants are the unique receivers of care from caregivers. Infants use caregivers as a safe haven from which they gain comfort and as a secure base from which to explore their environment. Unlike infant-caregiver relationships, in adult attachment relationships each adult can play the role of both care-receiver and care-giver (Hazan & Shaver, 1987, 1994; Weiss, 1982). As a receiver, one may rely on a romantic partner as a safe haven from which to gain comfort and as a secure base from which to explore the environments. As a caregiver, one can provide a safe haven and secure base to one's partner. Therefore, 'safe haven' and 'secure base' were measured from both the receiver and giver's perspective. Based on this, there were six sub-dimensions for adult attachment: *Care-receiving/safe haven* (a partner as a safe haven); *Care-receiving/secure base* (a partner as a secure base); *Care-giving/safe haven* (oneself as a partner's safe haven); *Care-giving /secure base* (oneself as a partner's secure base); *Proximity seeking* (proximity seeking towards a partner); and *Separation distress* (separation anxiety from a partner). Hence, a measure that covered all of these sub-dimensions was needed.

There are two research traditions in adult attachment research; a normative component and an individual-difference component (Simpson & Rholes, 1998). The former focuses on species-typical behavioural patterns and developmental stages of

attachment bonds, and the latter addresses individual differences in the expression of attachment mechanisms (Simpson & Rholes, 1998). Attachment theory proposes that infants develop a mental model through interactions with caregivers, and the quality of infant-caregiver attachment bonds affect the development of the internal working model (Bowlby, 1969). Ainsworth et al. (1978) observed how children reacted to separation from their caregivers and identified different attachment styles (e.g., secure, anxious/ambivalent, avoidant). Most subsequent studies have followed Ainsworth's influential study and focused on these individual-difference components (Simpson & Rholes, 1998). Indeed, when Hazan and Shaver (1987) first applied attachment theory to adult romantic relationships, they directed their attention to continuities of attachment styles between infancy and adulthood. Their study implied that attachment styles, which developed during infancy, continued in adulthood and different attachment styles predicted individuals' concepts and experiences of love.

Following this tradition, existing measurements of adult attachment are often focused on the assessment of attachment styles (e.g., Relationship Questionnaire; Bartholomew & Horowitz, 1991). However, the aim of the present thesis was to assess the intensity of attachment functions, rather than distinguishing types of attachment relationships. The most relevant measurement appeared to be Fraley and Davis (1997)'s WHOTO scale (a modified version of Hazan and Zeifman's scale, 1994) which measures the three functions of adult attachment (safe haven, secure base, and proximity seeking). However, it does not cover separation distress and does not include care-giver and care-receiver's perspectives. Thus, existing measurements of the functions of adult attachment were identified, and a new measure was synthesised using these items. Questions from existing romantic love scales were also considered if they contained items relevant to adult attachment. Items from the following scales were used: Relationship Rating Form (Davis & Todd, 1982), a modified version of Hazan and Zeifman (1994)'s WHOTO scale (Fraley & Davis, 1997), Romantic Attitude Rating Scale (Pedersen & Shoemaker, 1993), Affective Relationship Scale (Takahashi & Sakamoto, 2000), Attachment Features and Functions Scale (Tancredy & Fraley, 2006), and Attachment Relationship Questionnaire (Trinke & Bartholomew, 1997). Table 2 displays 24 items selected to measure the six functions of adult attachment (care-receiving/safe haven, care-receiving/secure base, care-giving/safe haven, care-giving/secure base, proximity seeking, and separation distress).

Table 2

Items for Adult Attachment

Sub-dimension	Item
Care-receiving Safe haven	- My partner helps me feel better when something bad happens to me, or I feel upset. - My partner is my primary source of emotional support. - I feel that my partner understands me when I have a hard time. - I would like to be with my partner when I feel sad.
Care-receiving Secure base	- I can count on my partner, and I think my partner will always be there for me and care about me in times of need. - My partner is whom I would count on for advice when something bad happens to me or I feel upset. - I know that my partner senses when I have a problem and will support me. - If I achieved something good, my partner is the person I would tell first.
Care-giving Safe haven	- I help my partner to feel better when something bad happens to him/her, or he/she feels upset. - I believe I am my partner's primary source of emotional support. - I try to understand my partner when he/she has a hard time. - I would like to be with my partner when he/she feels sad.
Care-giving Secure base	- I am prepared to be counted on by my partner, and I will always be there for and care about my partner in times of need. - I would like my partner to count on me for advice when something bad happens to her/him or she/he feels upset. - I try to sense if there is a problem with my partner and am willing to support her/him. - If my partner achieved something good, I would like to be the first person that he/she would tell.
Proximity seeking	- I like to see or talk with my partner regularly. - I like to be with my partner if possible. - My partner is the person whom I most like to spend time with.
Separation distress	- I do not like to be away from my partner. - If I were separated from my partner, I would feel down or lonely. - I would miss my partner if she/he was away. - My life would be severely disrupted if my partner was no longer a part of it. - If my partner was no longer accessible to me, I would feel greatly distressed.

Sexual Desire

In Chapter One, sexual desire was defined as 'an internal state of willingness or motivation to have sexual intercourse with an individual to whom one is sexually attracted'. Fisher (1998) proposed that sexual desire motivates individuals to seek sexual union with members of the opposite sex while romantic love leads individuals to prefer a particular mating partner. Based on this idea, two components were identified for sexual desire: sexual desire for a specific person (i.e., with whom one is in love) and sexual desire for others (i.e., any person other than this 'specific person'). Hence, a partner-directed sexual desire scale and an other-directed sexual desire scale were prepared for the present study.

As discussed in Chapter One, sexual desire was distinguished from sexual behaviours. Thus, a measurement which focuses on sexual desire but not on actual behaviours was needed. The Sexual Desire Inventory (SDI; Spector, Carey, & Steinberg, 1996) seemed to be a suitable measurement as it addresses only the level of sexual desire. SDI was developed using a sample of male and female undergraduate students. The scale is composed of items to assess two dimensions of sexual desire, such as *Dyadic sexual desire* and *Solitary sexual desire*. Dyadic desire refers to "interest in or a wish to engage in sexual activity with another person" while solitary desire refers to "an interest in engaging in sexual behaviour by oneself" (Spector, Carey, & Steinberg, 1996, p. 186). SDI items further address 'frequency' (e.g., "During this month, how often have you had sexual thoughts involving a partner?") and 'intensity' (e.g., "When you first see an attractive person, how strong is your sexual desire?") (Spector, Carey, & Steinberg, 1996, pp. 187-188).

The interest of the present thesis was sexual desire directed towards another person (romantic partners or extra-partners) but not desire to engage in sexual behaviours by oneself. Therefore, only dyadic desire items (SDI items 1-8) were selected to compose the partner- and other-directed sexual desire scales'. For each of the eight items, two versions were created. One set of items referred to 'your partner' and the other set to 'a person you find attractive (not your partner)'. Tables 3 and 4 show items for the sexual desire for a partner and others scales, respectively. For each scale, there were two items to assess frequency of sexual desire, and six items to measure intensity of sexual desire.

Table 3

Items for Partner-Directed Sexual Desire

Sub-dimension	Item
Frequency	- In a typical month, how often would you have liked to engage in sexual activity with your partner? - In a typical month, how often have you had sexual thoughts involving your partner?
Intensity	- When you have sexual thoughts how strong is your desire to engage in sexual behaviour with your partner? - When you see your partner, how strong is your sexual desire? - When you spend time with your partner (for example, at work or school), how strong is your sexual desire? - When you are in romantic situations with your partner (such as a candle-lit dinner, a walk on the beach, etc.), how strong is your sexual desire? - How strong is your desire to engage in sexual activity with your partner? - How important is it for you to fulfill your sexual desire through activity with your partner?

Note. A phrase 'In a typical month' in Frequency items and a phrase 'When you see your partner' in Intensity items were stated as 'During the last month' and 'When you first see an attractive person' in the original SDI, respectively.

Table 4

Items for Other-Directed Sexual Desire

Sub-dimension	Item
Frequency	- In a typical month, how often would you have liked to engage in sexual activity with a person you find attractive (not your partner)? - In a typical month, how often have you had sexual thoughts involving a person you find attractive (not your partner)?
Intensity	- When you have sexual thoughts, how strong is your desire to engage in sexual behaviour with a person you find attractive (not your partner)? - When you first see a person you find attractive (not your partner), how strong is your sexual desire? - When you spend time with a person you find attractive (not your partner) (for example, at work or school), how strong is your sexual desire? - When you are in romantic situations with a person you find attractive (not your partner) (such as a candle-lit dinner, a walk on the beach, etc.) how strong is your sexual desire? - How strong is your desire to engage in sexual activity with a person you find attractive (not your partner)? - How important is it for you to fulfill your sexual desire through activity with a person you find attractive (not your partner)?

Note. A phrase 'In a typical month' in Frequency items was stated as 'During the last month' in the original SDI.

Summary

The aim of this chapter was to select items in order to construct a self-report scale of pair-bond relationships. Based on Fisher's hypothesized relationship dimensions (i.e., romantic love, attachment, and sexual desire), four main dimensions were identified: romantic love; adult attachment; sexual desire for a partner; and sexual desire for others. Informed by attachment theory (e.g., Bowlby, 1969), the attachment dimension was further divided into four components: care-receiving and secure base; care-giving and safe haven; proximity seeking; and separation distress. Items were prepared for each dimension using existing scales and/or informed by their items. The dimensions measured and the number of items used were as follows: *Romantic love* (15 items); *Adult attachment care-receiving and safe haven* (four items); *Adult attachment care-receiving and secure base* (four items); *Adult attachment care-giving and safe haven* (four items); *Adult attachment care-giving and secure base* (four items); *Adult attachment proximity*

seeking (three items); *Adult attachment separation distress* (five items); *Sexual desire for a partner* (eight items); and *Sexual desire for others* (eight items). The questionnaire can be seen in Appendix A. The final questionnaire was included demographic measure (e.g., participants' age, relationship status) and the four scales of pair-bond relationship dimensions (the romantic love, adult attachment, sexual desire for a partner, and sexual desire for others scales). In the following chapter, this questionnaire was administered to Occidental and Japanese participants. Their responses were entered in factor analyses (Chapter Three) in order to confirm dimensions underlying pair-bond relationships, to refine measurement items for each component, and to examine the cross-cultural consistency of the factor structure.

Chapter Three
Scale Construction

In the previous chapter, I selected the items to measure the dimensions of pair-bond relationships such as romantic love, adult attachment, and sexual desire for a partner and others. The aims of the current study in this chapter were to (1) identify underlying factor structures for the observed datasets for Japanese and Occidental (British, European, North American, and Oceanian countries) groups, respectively; and (2) develop self-report scales to measure extracted factors common to the two cultural groups.

Method

Participants

The original sample was composed of 1,235 men and women over 18 years old who joined the study voluntarily. The sample was reduced to 931 after excluding participants who were recalling persons in the past when they were under 16 years of age, were not exclusively heterosexual, had never been in relationships, or had missing data in relationship dimensions-related items (between items 12 and 66; see Appendix A). Of the remaining sample, 43.93% of participants reported themselves as Japanese, 33.83% as British, 20.41% as European, 1.72% as North American, and 0.11% as Oceanian.

Data Collection

The participants completed either web- or paper-based questionnaires. The web-based questionnaire was provided in two languages (i.e., English and Japanese) with a separate link for each. These websites were advertised through different social networking services (e.g., Facebook). For the English website, it was also advertised in the official website of the department of psychology at Durham University (Durham, United Kingdom) with a link that took respondents to the questionnaire. In addition, the project was advertised in BBC local news by Prof Anne Campbell (Durham University). The web-based questionnaire was completed by students at Durham University and other adults from any part of the world. The order of questions in the web-based questionnaire (except for the demographic section) was randomized upon each online access. In addition, data were directly collected from Japanese undergraduate and mature students at Aichi Prefectural University (Nagoya, Japan), Hokusei Gakuen University (Sapporo, Japan), The Open University of Japan (Yokohama, Sapporo, and Tokyo centres, Japan), and Tokyo Metropolitan University (Tokyo, Japan) after distribution of the paper-based questionnaires at lectures. For the paper-based questionnaire, four versions were prepared to quasi-randomize the order of items.

Both web- and paper-based questionnaires began with a welcome page, followed by demographic questions, and then questions related to relationship dimensions. The welcome page explained that participants needed to be over 18 years old to participate in the study, their anonymity and confidentiality would be ensured, their involvement was voluntary, and they could withdraw from the questionnaire at any point (in which case, they were told that their data would not be included in the study). Participants were informed that the aim of the project was to explore the dimensions of pair-bond relationships.

Throughout the questionnaire, participants were instructed to think about a person with whom they were currently in love or had been in the past. If they were in relationships with several individuals, they were instructed to think about one person for whom they had the strongest feelings. For the participants who were not in a relationship at the time of answering the questionnaires, three options were given. They were asked to think about: the person with whom they were currently in love but separated from him/her; the person with whom they were currently in love even though that person was not aware of their feelings toward him/her (i.e., one-sided love); or the person who they loved the most in the past. If they had never been in love, they were asked to imagine how they thought they would feel if they were in love with someone. These participants were excluded from the analysis. In all cases, they were instructed to get a strong image of this person and their feelings about him/her in their mind.

As noted earlier, the current study used paper- and web-based data collection methods. This was done in order to increase the sample size as much as possible. For the English speaking sample, a web-based questionnaire was used, since Durham University's online participant pool was readily available, and the study (and its website) was advertised through media (e.g., local television news and a Durham University website). For the Japanese sample, paper-based questionnaires were mainly used, because Japanese universities and lecturers were reluctant to permit an author to advertise the study's website or to collect personal email addresses from their students. Although the use of both paper- and web-based data collection methods increased access to participants for the current study, some may have concerns about the use of both methods. Indeed, discussion has continued regarding issues which relate to the psychometric equivalence of these methods (e.g., reviewed in Noyes & Garland, 2008; Schulenberg & Yutrzenka, 1999). Although studies have shown mixed findings for the equivalence of the two methods, these findings might have been due to having different definitions for equivalence (Schulenberg & Yutrzenka, 1999) and the prevalence of methodological and statistical problems (e.g., non-equivalent samples, inappropriate statistical analyses for equivalence tests) in many previous studies (Weigold, Weigold, & Russell, 2013). Addressing these limitations (including experimenter effects), Weigold, Weigold, and

Russell (2013) examined the equivalence of paper- and web-based self-report survey designs. Their study showed that equivalence was generally achieved for quantitative (e.g., mean scores) and qualitative (e.g., internal consistency) equivalence. The improvement of technology (e.g., better computer screens) and greater computer familiarity in the general population may be contributing to greater equivalence today than in the past (Noyes & Garland, 2008). However, it may still be important to keep in mind that the use of the different administration modes may affect participants' responses.

Measures

The questionnaire (see Appendix A) was composed of the demographic measure and the scales of pair-bond relationship dimensions (the romantic love, adult attachment, sexual desire for a partner, and sexual desire for others scales) with items selected in the previous chapter.

Demographic measure. The demographic measure (items 1 to 11) asked participants' age at the time of answering the questionnaire, age at the time of being in love with a person in the past (if applicable), gender, sexual orientation, ethnic background, relationship status with the person (dating, engaged, married, separated/divorced, separated by death, and not in a relationship/one-sided love), relationship length (one-sided love participants were instructed to report how long they were in love with the person), the frequency of contact with the person (every day, every week, every month, every year, never), whether they had a sexual relationship with the person, whether they cohabitated with the person, whether they had a child or children with the person and, if so, their age. Female participants also asked if they had reached their menopause. Married participants were also asked if their marriages were arranged.

Romantic love scale. For the romantic love scale, the 15-item version of Passionate Love Scale (PLS; Hatfield & Sprecher, 1986) was used. The items shown in Table 1 were designed to measure the ten domains of 'passionate love': *Intrusive thinking or preoccupation with the partner* (items 13 and 22); *Idealization of the partner or of the relationship* (items 15 and 20); *Desire to know the partner and be known* (items 17 and 23); *Attraction to the partner, especially sexual attraction* (item 25); *Negative feelings when things go awry* (items 12, 16, 26); *Longing for reciprocity* (item 19); *Desire for complete union* (item 18); *Physiological arousal* (item 21); *Action toward determining the partner's feelings* (item 24); and *Services to the partner* (item 14). Respondents recorded their agreement with each statement on a 5-point Likert scale, where 1 = 'Disagree strongly' and 5= 'Agree strongly'.

Table 1

Romantic Love Scale: Sub-Dimensions and Items

Sub-dimensions	Items	
Intrusive thinking or preoccupation with the partner	13	Sometimes I feel I can't control my thoughts; they are obsessively on my partner.
	22	My partner always seems to be on my mind.
Idealization of the partner or of the relationship	15	I would rather be with my partner than anyone else.
	20	For me, my partner is the perfect romantic partner.
Desire to know the partner and be known	17	I yearn to know all about my partner.
	23	I want my partner to know me-my thoughts, my fears, and my hopes.
Attraction to the partner, especially sexual attraction	25	I possess a powerful attraction for my partner.
Negative feelings when things go awry	12	I would feel despair if my partner left me.
	16	I'd get jealous if I thought my partner was falling in love with someone else.
	26	I get extremely depressed when things don't go right in my relationship with my partner.
Longing for reciprocity	19	I have an endless appetite for affection from my partner.
Desire for complete union	18	I want my partner-physically, emotionally, mentally.
Physiological arousal	21	I sense my body responding when my partner touches me.
Action toward determining the partner's feelings	24	I eagerly look for signs indicating my partner's desire for me.
Services to the partner	14	I feel happy when I am doing something to make my partner happy.

Adult attachment scale. Table 2 shows 24 items on the adult attachment scale which were designed to measure the six sub-dimensions of adult attachment: *Care-receiving and safe haven* (items 27, 28, 29, and 30); *Care-receiving and secure base* (items 31, 32, 33, and 34); *Care-giving and safe haven* (items 35, 36, 37, and 38); *Care-giving and secure base* (items 39, 40. 41, and 42); *Proximity seeking* (items 43, 44, and 45); and *Separation distress* (items 46, 47, 48, 49, and 50). These sub-dimensions were based on the attachment theory (e.g., Bowlby, 1969) and selected and/or modified from existing measurements (see Chapter Two). Respondents recorded their agreement with each statement on a 5-point Likert scale, where 1 = 'Disagree strongly' and 5= 'Agree strongly'.

Table 2

Adult Attachment Scale: Sub-Dimensions and Items

Sub-dimensions	Items	
Care-receiving/ Safe haven	27	My partner helps me feel better when something bad happens to me, or I feel upset.
	28	My partner is my primary source of emotional support.
	29	I feel that my partner understands me when I have a hard time.
	30	I would like to be with my partner when I feel sad.
Care-receiving/ Secure base	31	I can count on my partner, and I think my partner will always be there for me and care about me in times of need.
	32	My partner is whom I would count on for advice when something bad happens to me or I feel upset.
	33	I know that my partner senses when I have a problem and will support me.
	34	If I achieved something good, my partner is the person I would tell first.
Care-giving/ Safe haven	35	I help my partner to feel better when something bad happens to him/her, or he/she feels upset.
	36	I believe I am my partner's primary source of emotional support.
	37	I try to understand my partner when he/she has a hard time.
	38	I would like to be with my partner when he/she feels sad.
Care-giving/ Secure base	39	I am prepared to be counted on by my partner, and I will always be there for and care about my partner in times of need.
	40	I would like my partner to count on me for advice when something bad happens to her/him or she/he feels upset.
	41	I try to sense if there is a problem with my partner and am willing to support her/him.
	42	If my partner achieved something good, I would like to be the first person that he/she would tell.
Proximity seeking	43	I like to see or talk with my partner regularly.
	44	I like to be with my partner if possible.
	45	My partner is the person whom I most like to spend time with.
Separation distress	46	I do not like to be away from my partner.
	47	If I were separated from my partner, I would feel down or lonely.
	48	I would miss my partner if she/he was away.
	49	My life would be severely disrupted if my partner was no longer a part of it.
	50	If my partner was no longer accessible to me, I would feel greatly distressed.

Sexual desire scales. Tables 3 and 4 show eight items each for *Sexual desire for a partner* (items 51 to 58) and *Sexual desire for others* (items 59 to 66) scales. These items were based on Sexual Desire Inventory (SDI; Spector, Carey, & Steinberg, 1996). Each subscale has frequency and intensity sub-dimensions. The frequency items have an 8-point Likert response scale, where 1 = 'Not at all' and 8 = 'More than once a day' for items 51 and 59, and 1 = 'Not at all' and 8 = 'Many times a day' for items 52 and 60. The intensity items have a 5-point Likert-response scale, where 1= 'No desire' and 5 =

'Very strong desire' for items 53 to 57, and for 61 to 65, and 1 = 'Not at all important' and 5 = 'Extremely important' for items 58 and 66.

Table 3

Sexual Desire for a Parter Scale: Sub-Dimensions and Items

Sub-dimensions	Items	
Frequency	51	In a typical month, how often would you have liked to engage in sexual activity with your partner?
	52	In a typical month, how often have you had sexual thoughts involving your partner?
Intensity	53	When you have sexual thoughts how strong is your desire to engage in sexual behaviour with your partner?
	54	When you see your partner, how strong is your sexual desire?
	55	When you spend time with your partner (for example, at work or school), how strong is your sexual desire?
	56	When you are in romantic situations with your partner (such as a candle-lit dinner, a walk on the beach, etc.) how strong is your sexual desire?
	57	How strong is your desire to engage in sexual activity with your partner?
	58	How important is it for you to fulfill your sexual desire through activity with your partner?

Table 4

Sexual Desire for Others Scale: Sub-Dimensions and Items

Sub-dimensions	Items	
Frequency	59	In a typical month, how often would you have liked to engage in sexual activity with a person you find attractive (not your partner)?
	60	In a typical month, how often have you had sexual thoughts involving a person you find attractive (not your partner)?
Intensity	61	When you have sexual thoughts, how strong is your desire to engage in sexual behaviour with a person you find attractive (not your partner)?
	62	When you first see a person you find attractive (not your partner), how strong is your sexual desire?
	63	When you spend time with a person you find attractive (not your partner) (for example, at work or school), how strong is your sexual desire?
	64	When you are in romantic situations with a person you find attractive (not your partner) (such as a candle-lit dinner, a walk on the beach, etc.) how strong is your sexual desire?
	65	How strong is your desire to engage in sexual activity with a person you find attractive (not your partner)?
	66	How important is it for you to fulfill your sexual desire through activity with a person you find attractive (not your partner)?

Back-translation of the questionnaire. The questionnaire was first written in English. For Japanese speakers, the questionnaire was then translated into Japanese and back-translated to English. The back-translation was used to examine whether the initial translations (from English into Japanese) were done without changing the meaning of the

original questions written in English. Translation was done by native Japanese speakers (Rei Shimoda and Ms. Tamami Kiyasu), and the back-translation was done by a different native Japanese speaker with excellent English language skills (Mr. Kado Shunsuke). This back-translation process for the romantic love scale was not done in the present study, as there was already an existing Japanese version of PLS (Kawano, Hanari, Tsuda, & Lafaye, 2008).

Overview of Statistical Analyses

The main goals of this study were: (1) to identify underlying factor structures for the observed datasets for Japanese and Occidental (British, European, Oceanian, North American) groups, respectively; and (2) to develop scales to measure extracted factors common for the two cultural groups.

Identification of factor structures using principle axis factor analysis. First, to identify underlying factor structures of pair-bond relationships for the observed datasets, exploratory factor analysis was conducted for Japanese and Occidental groups, respectively. The rationale for using exploratory factor analysis initially was to test whether the dimensions of pair-bond relationships are composed of the conceptual distinctions made by other researchers (e.g., Fisher, 1998), that are romantic love, adult attachment, sexual desire for a partner and others.

Regarding the factor extraction procedure, principal axis factor analysis (PAF) is desirable if researchers have a prior theoretical conception of relationship between observed variables and the latent factors so that they want to focus only on the common variance (Brown, 2009). Thus, PAF was chosen in the current study, because the measurements were developed to assess the dimensions that were theorized to compose pair-bond relationships (e.g., Fisher, 1998). Regarding rotation method, oblique rotation is recommended if researchers want to permit underlying factors to be related, and if data used in analyses are non-experimental data collected from humans (Field, 2009). Hence, the oblique rotation (promax) was used in the current study, because the dimensions of pair-bond relationships have been suggested to be associated with each other (Fisher, 1998), and the current study was based on human data. Regarding factor extraction criteria, Kaiser's criterion, a scree test, and a parallel analysis for PAF (O'Connor, 2000) were used to determine the number of factors to retain. Kaiser's criterion is applicable if the sample size is over 250, and the average of the communalities is around .60 or greater. The scree test can be applied with over 200 cases (Field, 2009). The parallel analysis of adjusted correlation matrices may have a tendency to extract more components than warranted (Buja & Eyuboglu, 1992); thus, this criteria were used with caution.

Refinement of measurements using confirmatory factor analysis. Having established the underlying factorial structure, confirmatory factor analysis (CFA) was

used to refine the measurement items for each factor using diagnostic statistics for the Japanese and Occidental groups, respectively. Generally, the primary use of CFA is to test how well the researcher's prior conception of latent factors underlying the measurement instrument fit the factorial structures observed in the data, but it can also be used to refine the measurement items for each factor in order to make them as economical and specific as possible. In the current study, CFA was used for this latter purpose. CFA gives diagnostic guidelines to trim the model by suggesting modification to proposed model (Floyd & Widaman, 1995). For this reason, a rather large numbers of items (i.e., 55 items) were initially selected, as described in the previous chapter.

The fit between the observed data and the model derived from the former PAF was assessed to improve the measurement model (the correspondence between items and factors) for the two groups, respectively. These fit statistics are the chi-squared (χ^2) goodness-of-fit statistic (reviewed in Jöreskog& Sörbom, 2001), the goodness-of-fit index (GFI; reviewed in Mulaik et al., 1989), the comparative fit index (CFI; Bentler, 1990), and the root-mean-square-error of approximation (RMSEA; Steiger & Lind, 1980). The χ^2 statistic assesses the extent of discrepancy between the model and observed data; thus, non-significance indicates a good fit. However, it is generally recognised to be an over-stringent fit criterion being highly sensitive to sample size (Bentler & Bonett, 1980; Jöreskog, 1969). Consequently, greater weight will be given to other fit indices. GFI, CFI, and RMSEA assess how well the model fits the observed data, and their values range from zero to one. The values closer to one indicate a *better* fit for GFI and CFI and a *worse* fit for RMSEA. To accept the model, the values of GFI and CFI are recommended to be above .90 (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999) and for RMSEA to be close to .06 (Hu & Bentler, 1999), ideally .05 or less (Browne & Cudeck, 1992). Subsequently, diagnostic indices were used to analyse how the model fit could be improved.

Reliability analysis. Internal consistency for each subscale derived from the factor analyses was assessed by using Cronbach's alpha (Cronbach, 1951). It assesses the consistency of a set of items in measuring a single underlying construct therefore the internal reliability is a characteristic of a set of items for a particular group of participants at a certain time. Its values theoretically range between zero and one, with the value of zero indicating a set of items that are independent of one another (reviewed in Bland & Altman, 1997; Brown, 2002; Streiner, 2003). The α value around .80 is a commonly accepted rule of thumb for indicating satisfactory internal consistency (e.g., Bland & Altman, 1997; Field, 2009; Streiner, 2003).

Criteria for running analysis. In performing PAF and CFA, I followed several criteria. The criteria of PAF were as follows: (1) an item loading below .40 on any factor or an item loading above .40 on more than one factor was considered for elimination; (2)

when an item was dropped, PAF was re-run; and (3) PAF was repeated until the solution reached the state that every item was loading above .40 on a factor. After reaching this state, internal consistency for each derived scale was computed. An item was considered for deletion if it improved the internal consistency for each scale. If an item was dropped at this stage, PAF was also re-run.

After PAF, CFA was conducted. The criteria of CFA were as follows: (4) an item was considered for elimination if modification indices suggested that deletion of the item would improve the model fit, but consideration was also given to the item's factor loading and communality, the numbers of items per factor, and how item deletion would affect the total variance and internal consistency of its sub-scales; (5) PAF was re-run after the deletion of an item in CFA, and the cycle repeated until the model reached good fit; and (6) internal consistency reliability analysis was run for each subscale in the final solution.

Construction of the common scales and the evaluation of multi-group measurement equivalence using multi-group CFA. If romantic love is part of universal human nature, similarities in the number of factors extracted and items loading on each factor between the two cultural groups were expected. In this case, a measurement to assess the dimensions of pair-bond relationships for both groups was constructed from common items loading on each factor.

After the construction of the common scales, the measurement equivalence was examined over the Japanese and Occidental groups simultaneously. Using multi-group CFA, three steps were followed (see Byrne, 2001; Vandenberg & Lance, 2000). First, a test of configural invariance was conducted to test the validity of the factorial structure across the groups with no constraints on factor loadings. The main fit indices in this step were CFI, RMSEA, and χ^2 statistic, in which CFI and RMSEA values show a model fit across the groups while χ^2 value provided the baseline value that would be compared to χ^2 values in a subsequent test. Second, if configural invariance was established (i.e., having a good model fit across the groups), a test of metric invariance was conducted with factor loadings constrained to be equal across the groups. This tested whether the pattern of factor loadings was equivalent across the two groups. This constrained model's χ^2 value was compared to the baseline χ^2 value in the first step. If this comparison shows that equality constraints do not hold across the groups, items that showed the greatest difference in loadings between the groups were considered for removal. Third, if metric invariance was supported (i.e., the comparison was non-significant), I tested whether the extracted factors showed the same pattern of inter-correlations across the two groups. The third model's χ^2 value was compared to the former (i.e., the second step) χ^2 value.

The Current Study

Preliminary analysis. The main goal of the current study was to construct common scales to assess the dimensions of pair-bond relationships for two cultural groups: Japanese and Occidental. In the current study, the term 'Occidental' was used to describe respondents from United Kingdom, Europe, North America, and Oceania. Before performing factor analyses on the Occidental and Japanese groups, consideration was given to European participants, because they might not have fully understood the questions written in English as English was not the native language for most of them. In order to assess whether adding the European participants' data to the Occidental group would be appropriate, preliminary factor analyses (PAF and CFA) were firstly performed on the native English-speaking group (United Kingdom, North America, and Oceania), and a six-factor solution was confirmed. In the next stage, the European data were added to the English-speaking sample to compose the Occidental group, and CFA tested how well the factor structure identified in the factor analysis of native English-speaking group fitted the observed data of the Occidental countries. Diagnostic information indicated that the model identified from the native English-speaking group fitted well to the observed data of the expanded Occidental group, GFI = .92; CFI = .96; RMSEA = .04, 90% CI [.04, .05]. Thus, European participants were included to constitute the Occidental group. This preliminary analysis is described in Appendix C.

Main analyses. There were three steps in the current study. (1) In order to make comparison between the Japanese and Occidental groups, the characteristics of each sample should be ideally the same or at least similar to each other. Hence, the frequencies of age, relationship length, relationship status, and the sex ratio in two groups were examined. In order to make frequency characteristics as similar as possible in the two samples, some cases were randomly removed. To proceed with common factor analysis, the minimum sample size of 300 is recommended (Tabachnick & Fidell, 2001). The minimum case-to-variable ratio should be at least five to one for both common factor analysis (Gorsuch, 1983) and confirmatory factor analysis (Floyd & Widaman, 1995). Overall there were 55 variables in the current study; thus, at least 275 cases were required to run factor analyses. Therefore, deletion of cases from the datasets within the limits of the minimum amount (no less than $N = 300$) were conducted prior to conducting PAF and CFA. (2) Next, after adjusting the proportions of demographic characteristics for the two groups, PAF and CFA were performed on the Japanese and Occidental groups separately. (3) Common measurement scales were constructed and the measurement equivalence was tested by using multi-group CFA invariance analysis.

Results

Sample Reduction

There were 409 participants in the Japanese group and 522 participants in the Occidental group (United Kingdom = 315, Europe = 190, North America = 16, and Oceania = 1). First, the data were screened for outliers, and cases were removed from the Japanese (n = 14) and Occidental groups (n = 22). This reduced the sample size to 395 for the Japanese group and 501 for the Occidental group.

In order to make the demographic characteristics of the two groups similar to each other, sex ratio, the frequency of age, relationship length, and relationship status in samples were adjusted by randomly removing some cases from each group. The left side of Table 5 shows demographic characteristics of the two groups before the removal of cases. Regarding the sex ratio in groups, there were more females than males in both groups, but the sex ratio was more female-biased in the Occidental group (77.64 %) than the Japanese group (61.01%). Regarding age of participants, there were more teenage participants in the Japanese group (30.13%) than the Occidental group (18.76%). With regard to relationship length, the proportion of relationship length below six months was over 28% in the Japanese group while it was around 14% in the Occidental group. Regarding the frequency of relationship status, fewer participants were in relationships in the Japanese group (52.66%) compared to the Occidental group (70.66%).

In order to make the two groups as similar as possible, some cases were randomly removed from each group within the limits of the minimum sample size for conducting PAF. Consequently, the total sample size was decreased from 395 to 328 in the Japanese group and from 501 to 330 in the Occidental group (United Kingdom = 198, Europe = 122, North America = 9, and Oceania= 1). The right side of Table 5 shows demographic characteristics of the two groups after the elimination of cases. In both groups, the proportions of females and males (approximately two-thirds female), teenagers (around 25%), relationship lengths below six months (around 19%), and participants in relationships (around 65%) were more similar.

Table 5

The Proportions (%) of Sex, Age, Relationship Length, and Relationship Status in the Japanese and the Occidental Groups Before and After Removing Cases

	Before (%)		After (%)	
	Japan	Occident	Japan	Occident
Sex				
Male	38.99	22.36	34.15	26.97
Female	61.01	77.64	65.85	73.03
Age				
10s	30.13	18.76	25.30	26.06
20s	40.00	46.11	39.94	39.39
30s	11.14	14.37	12.80	11.82
40s	7.85	9.98	9.45	9.70
50s	7.85	6.59	8.84	8.79
over 60s	3.04	4.19	3.66	4.24
Relationship length				
Less than 3 months	17.47	5.99	10.98	8.18
3 to 6 months	10.63	8.38	8.54	10.00
6 months to 1 year	14.18	12.97	14.33	15.15
1 to 3 years	23.80	30.14	28.05	27.58
3 to 5 years	8.61	15.37	10.37	12.12
5 to 10 years	6.84	11.18	8.23	9.70
10 years or more	15.70	14.77	18.29	16.06
Relationship status				
Dating	32.15	44.91	39.02	38.18
Engaged or married	20.51	25.75	24.70	26.97
Past relationships	21.01	9.18	15.24	13.94
Separated by death	0.25	0.60	0.30	0.91
One-sided love	26.08	19.56	20.73	20.00

For the next sets of analyses, the data of each group were screened for univariate outliers on each item. As a results, four cases from the Japanese group were removed which consequently decreased the total sample size from 328 to 324. In the Occidental group, 26 cases were removed which consequently decreased the total sample size from 330 to 304 (United Kingdom = 186, Europe= 108, North America= 9, and Oceania= 1). The deletion of outliers did not make the samples less equivalent (see Appendix B).

Japanese Group: Factor Analyses

A series of principle axis factor analysis (PAF) and confirmatory factor analysis (CFA) were conducted on the Japanese group. There were 214 females and 110 males aged between 16 and 69 years old (M = 29.28, SD = 13.30 with 95% CI [27.82, 30.73]). Every participant was over 18 years old when they joined the study, but their age at the time when they reported being in love was considered. Therefore, for those participants who thought about a person from their past, their age at that time was used instead of their current age (but no younger than 16 year-old). This rule was applied to other analyses as well.

Principle axis factor analysis. First, PAF was used to identify underlying factor structures of pair-bond relationships for the observed dataset. In the initial analysis, 50 variables were entered after removing the items (53, 60, 61, 63, and 64) each of which was highly correlated (r > .80) with one or more other items. The case-to-variable ratio was above six to one which reached the minimum level to proceed with the factor analysis. The communalities were all above .32 (M = .58). The Kaiser-Myer-Olkin (KMO) measure was .93 which exceeded the acceptable limit (i.e., > .05), demonstrating very good sampling adequacy (Hutcheson & Sofroniou, 1999). Bartlett's test of sphericity was significant, χ^2 (1225) = 10655.32, p < .001, which showed that the correlation matrix was not an identity matrix. These tests together showed that the data were appropriate for factor analysis. PAF was repeated according to the analysis criteria (1), (2), and (3). During the analytic iterations, 17 items were dropped for the following reasons: loading on one or more factors (items 15, 20, 25, and 28), failing to meet the >.40 loading criterion (items14, 16, 21, 23, 26, 30, 34, 42, 43, 44, 45, and 46), and improvement of internal consistency (item 59).

For the final analysis, the remaining 33 variables were entered. The KMO measure (= .91) passed the acceptable limit. Bartlett's test of sphericity was significant, χ^2 (528) =6435.82, p < .001. The communalities were all above .41 (M = .59). Six factors had eigen values above Kaiser's criterion of one, and together explained 66.0% the variance. The scree test suggested a five-factor solution. The parallel analysis (O'Connor, 2000) suggested a seven-factor solution, but the analysis has a tendency to extract more factors than warranted (Buja & Eyuboglu, 1992). Given the large sample size and average of the communalities, it might be safe to assume Kaiser's criterion. Considering these factor extraction criteria together, six factors were retained in the final solution and presented in Table 6. Factor 1 explained 30.08% of variance, 13.28% was explained by factor 2, 9.60% by factor 3, 5.69% by factor 4, 4.24% by factor 5, and 3.11% by factor 6.

Table 6

Factor Loadings for the (Pre-)Final Solution of PAF for the Japanese Group*

Items from each of six relationship dimensions scales and their sub-dimensions in brackets.	Factors					
	1	2	3	4	5	6
57 Sexual desire for a partner (Intensity)	.93					
54 Sexual desire for a partner (Intensity)	.88					
51 Sexual desire for a partner (Frequency)	.76					
55 Sexual desire for a partner (Intensity)	.76					
56 Sexual desire for a partner (Intensity)	.71					
52 Sexual desire for a partner (Frequency)	.65					
58 Sexual desire for a partner (Intensity)	.59					
33 Attachment (Care-receiving/secure base)		.93				
29 Attachment (Care-receiving/safe haven)		.80				
31 Attachment (Care-receiving/secure base)		.78				
27 Attachment (Care-receiving/safe haven)		.71				
32 Attachment (Care-receiving/secure base)		.60				
36 Attachment (Care-giving/safe haven)		.57				
41 Attachment (Care-giving/secure base)			.79			
37 Attachment (Care-giving/safe haven)			.78			
38 Attachment (Care-giving/safe haven)			.76			
35 Attachment (Care-giving/safe haven)			.72			
40 Attachment (Care-giving/secure base)			.69			
39 Attachment (Care-giving/secure base)			.53			
22 Romantic love (Intrusive thinking)				.81		
19 Romantic love (Longing for reciprocity)				.79		
13 Romantic love (Intrusive thinking)				.66		
24 Romantic love (Action toward determing the partner's feelings)				.56		
17 Romantic love (Desire to know the partner and to be known)				.54		
18 Romantic love (Desire for complete union)				.50		
50 Attachment (Separation distress)					.72	
12 Romantic love (Negative feelings when things go awry)					.70	
49 Attachment (Separation distress)					.69	
47 Attachment (Separation distress)					.67	
48 Attachment (Separation distress)					.62	
65 Sexual desire for others (Intensity)						.90
62 Sexual desire for others (Intensity)						.82
66 Sexual desire for others (Intensity)						.75

Note. * Only loadings >.40 are reported.

Confirmatory factor analysis. CFA diagnostics were consulted to see if the model fit could be improved. A six-factor structure (allowing for correlated factors) was specified with a total of 33 variables: factor 1 (seven items); factor 2 (six items); factor 3 (six items); factor 4 (six items); factor 5 (five items); and factor 6 (three items). A case-to-variable ratio was around 10 to one which passed the acceptable limits to proceed with CFA. The chi-squared test showed that the model and the actual data were significantly different, χ^2 (480) =1050.30, $p < .001$, but in large samples the chi-squared test inclines to reject any model as insufficient (Bentler & Bonett, 1980). CFI (= .91) exceeded the .90 threshold. However, RMSEA (= .06 with 90% CI [.06, .07]) was not below the threshold of .06 and GFI (= .84) did not reach the .90 threshold. The fit indices together indicated that the model needed further improvement.

CFA (and PAF) were repeated according to the analysis criteria (4) and (5). During iteration of the analyses, items were dropped because modification indices suggested their deletion would improve the model fit. The following items were dropped: Items 51 and 55 (from the factor 1); 32 and 36 (from factor 2); 39 and 40 (from factor 3); and 18 (from factor 4). In the final solution of CFA, although the chi-squared test was still significant, χ^2 (284) = 482.21, $p < .001$, the other fit indices indicated that the model fit was good, GFI = .90, CFI = .95, and RMSEA= .05 with 90% CI [.04, .05].

PAF was re-run with the remaining 26 items. The KMO measure (= .89) passed the acceptable limit. Bartlett's test of sphericity was significant, χ^2 (325) = 4530.51, $p < .001$. The communalities were all above .40 (M = .60). The six-factor solution suggested by Kaiser's criterion, the scree test, and the parallel analysis (O'Connor, 2000) remained unchanged. Table 7 shows the pattern matrix from the final solution. Six factors together explained 68.79% of the variance, an improvement on the previous PFA (66.0%). Given the nature of the items loadings, the following names were given to the factors (with associated percentages of variances explained): *Sexual desire for a partner* (29.07 %); *Adult attachment/care-receiving* (14.08%); *Separation distress* (10.92 %); *Obsession* (6.14 %); *Adult attachment/care-giving* (4.73%); and *Sexual desire for others* (3.85 %).

Table 7

Factor Loadings for the Final Solution of PAF for the Japanese Group after Measurement Refinement by CFA

Items from each of six relationship dimensions scales and their sub-dimensions in brackets.	Factors					
	1	2	3	4	5	6
57 Sexual desire for a partner (Intensity)	.99					
54 Sexual desire for a partner (Intensity)	.80					
56 Sexual desire for a partner (Intensity)	.76					
58 Sexual desire for a partner (Intensity)	.59					
52 Sexual desire for a partner (Frequency)	.56					
33 Attachment (Care-receiving/secure base)		.86				
31 Attachment (Care-receiving/secure base)		.78				
29 Attachment (Care-receiving/safe haven)		.78				
27 Attachment (Care-receiving/safe haven)		.72				
12 Romantic love (Negative feelings when things go awry)			.72			
47 Attachment (Separation distress)			.71			
49 Attachment (Separation distress)			.71			
50 Attachment (Separation distress)			.70			
48 Attachment (Separation distress)			.62			
22 Romantic love (Intrusive thinking)				.82		
19 Romantic love (Longing for reciprocity)				.71		
13 Romantic love (Intrusive thinking)				.67		
24 Romantic love (Action toward determing the partner's feelings)				.52		
17 Romantic love (Desire to know the partner and to be known)				.52		
41 Attachment (Care-giving/secure base)					.82	
37 Attachment (Care-giving/safe haven)					.77	
35 Attachment (Care-giving/safe haven)					.72	
38 Attachment (Care-giving/safe haven)					.69	
65 Sexual desire for others (Intensity)						.91
62 Sexual desire for others (Intensity)						.83
66 Sexual desire for others (Intensity)						.74

Note. Factor 1 was labelled as sexual desire for a partner, factor 2 as adult attachment/care-receiving, factor 3 as separation distress, factor 4 as obsession, factor 5 as adult attachment/care-giving, factor 6 as sexual desire for others.

Occidental Group: Factor Analyses

A series of PAF and CFA were conducted on the Occidental group. There were 219 females and 85 males aged between 16 and 83years old (M = 29.20, SD = 13.42 with 95% CI [27.69, 30.71]).

Principle axis factor analysis. First, PAF was used to identify the underlying factor structure of the dataset. In the initial analysis, 53 variables were entered after removing the items (61 and 64) which were highly correlated (r > .80) with one or more other items. The case-to-variable ratio was above five to one. The communalities were all above .34 (M = .53). The KMO measure of .91 passed the acceptable limit. Bartlett's

test of sphericity was significant, χ^2 (1378) =8783.22, $p < .001$. These indices together demonstrated that the data were appropriate for factor analysis. PAF was repeated according to the analysis criteria (1), (2), and (3). During the analytic iterations, 19 items were dropped: one loaded on one or more factor (item 26); 16 failed to meet the >.40 loading criterion (items 14, 15, 16, 18, 21, 23, 35, 30, 34, 36, 42, 43, 44, 45, 46, and 48); and the deletion of two item (items 20 and 66) improved the internal consistency.

For the final analysis, 34 variables were entered. The KMO measure (= .88) passed the acceptable limit. Bartlett's test of sphericity was significant, χ^2 (561) = 5347.88, $p < .001$. The communalities were all above .28 (M = .56). Six factors had eigen values above Kaiser's criterion of one, and together explained 62.27% of the variance. The six-factor solution was also confirmed by the scree test and by parallel analysis (O'Connor, 2000). Considering these factor extraction criteria together, six factors were retained in the final solution and these are presented in Table 8. Factor 1 explained 22.01 % of variance, 16.48 % of the variance was explained by factor 2, 8.93 % by factor 3, 7.06 % by factor 4, 4.21 % by factor 5, and 3.58 % by factor 6.

Table 8

Factor Loadings for the (Pre-)Final Solution of PAF for the Occidental Group*

Items from each of six relationship dimensions scales and their sub-dimensions in brackets.	Factors					
	1	2	3	4	5	6
57 Sexual desire for a partner (Intensity)	.87					
54 Sexual desire for a partner (Intensity)	.80					
53 Sexual desire for a partner (Intensity)	.74					
58 Sexual desire for a partner (Intensity)	.72					
55 Sexual desire for a partner (Intensity)	.72					
51 Sexual desire for a partner (Frequency)	.70					
56 Sexual desire for a partner (Intensity)	.69					
52 Sexual desire for a partner (Frequency)	.67					
62 Sexual desire for others (Intensity)		.87				
65 Sexual desire for others (Intensity)		.87				
63 Sexual desire for others (Intensity)		.82				
60 Sexual desire for others (Frequency)		.82				
59 Sexual desire for others (Frequency)		.73				
29 Attachment (Care-receiving/safe haven)			.82			
27 Attachment (Care-receiving/safe haven)			.78			
33 Attachment (Care-receiving/secure base)			.76			
31 Attachment (Care-receiving/secure base)			.68			
32 Attachment (Care-receiving/secure base)			.63			
28 Attachment (Care-receiving/safe haven)			.47			
38 Attachment (Care-giving/safe haven)				.71		
41 Attachment (Care-giving/secure base)				.69		
37 Attachment (Care-giving/safe haven)				.66		
39 Attachment (Care-giving/secure base)				.61		
40 Attachment (Care-giving/secure base)				.60		
35 Attachment (Care-giving/safe haven)				.56		
49 Attachment (Separation distress)					.77	
12 Romantic love (Negative feelings when things go awry)					.77	
50 Attachment (Separation distress)					.73	
47 Attachment (Separation distress)					.48	
13 Romantic love (Intrusive thinking)						.81
22 Romantic love (Intrusive thinking)						.71
24 Romantic love (Action toward determing the partner's feelings)						.50
19 Romantic love (Longing for reciprocity)						.41
17 Romantic love (Desire to know the partner and to be known)						.41

Note. * Only factors loadings >.40 are shown.

Confirmatory factor analysis. A six-factor structure (allowing for correlated factors) was specified with a total of 34 variables: factor 1 (eight items); factor 2 (five items); factor 3 (six items); factor 4 (six items); factor 5(four items); and factor 6 (five items). The case-to-variable ratio was approximately nine to one which passed the acceptable limit to proceed with CFA. The chi-squared test of goodness-of-fit yielded a significant difference between the model and data, χ^2 (512) = 884.50, $p < .001$. Although

CFI (.93) and RMSEA (.05 with 90% CI [.04, .05]) met acceptable thresholds (above .90 and below .06, respectively), GFI (.86) did not reach .90, which indicated that the model needed improvement.

CFA (and PAF) were repeated according to the analysis criteria (4) and (5). During iteration of the analysis, the following items were dropped because modification indices suggested their deletion would improve the model fit: Items 52, 55, and 56 (from factor 1); 59 (from factor 2); 28 (from factor 3); and 39 (from factor 4). In the final solution, although the chi-squared test was still significant, χ^2 (335) = 498.69, $p < .001$, the other indices indicated the good model fit, GFI = .90, CFI = .96, and RMSEA = .04 with 90% CI [.03, .05].

PAF was re-run with the remaining 28 items. The KMO measure (.87) passed the acceptable limit. Bartlett's test of sphericity was significant, χ^2 (378) = 4002.68, $p < .001$. The communalities were all above .29 (M = .55). A six-factor solution was suggested by Kaiser's criterion, the scree test, and the parallel analysis (O'Connor, 2000). Table 9 shows the pattern matrix from the final solution. Six factors together explained 64.36% of the variance, an improvement on the previous PAF solution (62.27%). Given the nature of the items loadings, the following names were given to the factors (with associated percentages of variances explained): *Adult attachment/care-receiving* (23.04 %); *Sexual desire for others* (15.09 %); *Sexual desire for a partner* (9.40 %); *Obsession* (7.93 %); *Adult attachment/care-giving* (4.80 %); and *Separation distress* (4.10 %).

Table 9

Factor Loadings for the Final Solution of PAF for the Adjusted Occidental Group after Measurement Refinement by CFA

Items from each of six relationship dimensions scales and their sub-dimensions in brackets.	Factors					
	1	2	3	4	5	6
29 Attachment (Care-receiving/safe haven)	.85					
33 Attachment (Care-receiving/secure base)	.75					
27 Attachment (Care-receiving/safe haven)	.72					
31 Attachment (Care-receiving/secure base)	.67					
32 Attachment (Care-receiving/secure base)	.64					
65 Sexual desire for others (Intensity)		.89				
62 Sexual desire for others (Intensity)		.88				
63 Sexual desire for others (Intensity)		.86				
60 Sexual desire for others (Frequency)		.76				
57 Sexual desire for a partner (Intensity)			.88			
53 Sexual desire for a partner (Intensity)			.76			
58 Sexual desire for a partner (Intensity)			.72			
54 Sexual desire for a partner (Intensity)			.72			
51 Sexual desire for a partner (Frequency)			.68			
13 Romantic love (Intrusive thinking)				.84		
22 Romantic love (Intrusive thinking)				.70		
24 Romantic love (Action toward determing the partner's				.53		
17 Romantic love (Desire to know the partner and to be				.44		
19 Romantic love (Longing for reciprocity)				.43		
38 Attachment (Care-giving/safe haven)					.70	
41 Attachment (Care-giving/secure base)					.68	
37 Attachment (Care-giving/safe haven)					.66	
40 Attachment (Care-giving/secure base)					.60	
35 Attachment (Care-giving/safe haven)					.58	
12 Romantic love (Negative feelings when things go awry)						.78
49 Attachment (Separation distress)						.77
50 Attachment (Separation distress)						.74
47 Attachment (Separation distress)						.50

Note. Factor 1 was labelled as adult attachment/care-receiving, factor 2 as, sexual desire for others factor 3 as sexual desire for a partner, factor 4 as obsession, factor 5 as adult attachment/care-giving, factor 6 as separation distress.

Construction of the Common Scales and the Evaluation of Measurement Equivalence using Multi-Group CFA

In order to construct common scales of the relationship dimensions for the two cultural groups, their factor structures were compared. Table 10 shows the final solution with factor loadings, item number and sub-dimensions in the original scale for the Japanese and Occidental groups, respectively. Items with daggers denote items common

to the two groups. The factors from the Japanese group are presented in order of their emergence from one to six, and the Occidental group's factors are ordered to align with the factors of the Japanese group. The factor structures of the two groups were very similar to each other: both groups generated six factors each; the items loading on each of the six factors were mainly the same with minor differences; and the same factor labels (*Obsession*, *Adult attachment/care-receiving*, *Adult attachment/care-giving*, *Separation distress*, *Sexual desire for a partner*, and *Sexual desire for others*) could be used when naming the six factors in each group. Between the two groups, five items (13, 19, 17, 22, and 24) were common for obsession, four items (27, 29, 31, and 33) for care-receiving, four items (35, 37, 38, and 41) for care-giving, four items (12, 47, 49, 50) for separation distress, three items (54, 57, and 58) for sexual desire for a partner, and three items (62,and 65) for sexual desire for others. Thus, common scales were constructed for each of the six factors using these 22 common items.

Table 10

The Final Six-Factor Solution for the Japanese and Occidental Groups with Factor Loadings and Items' Number and Sub-Dimensions in the Original Scale

The Japanese group		The Occidental group	
Sexual desire for a partner (Factor 1)		Sexual desire for a partner (Factor 3)	
SP57 Intensity†	.99	SP57 Intensity†	.88
SP54 Intensity†	.80	SP58 Intensity†	.72
SP58 Intensity†	.59	SP54 Intensity†	.72
SP56 Intensity	.76	SP51 Frequency	.68
SP52 Frequency	.56	SP53 Intensity	.76
Adult attachment/Care-receiving (Factor 2)		Adult attachment/Care-receiving (Factor 1)	
AA33 Secure base†	.86	AA29 Safe haven†	.85
AA31 Secure base†	.78	AA33 Secure base†	.75
AA29 Safe haven†	.78	AA27 Safe haven†	.72
AA27 Safe haven†	.72	AA31 Secure base†	.67
		AA32 Secure base	.64
Separation distress (Factor 3)		Separation distress (Factor 3)	
RL12 Negative feelings when things go awry†	.72	RL12 Negative feelings when things go awry†	.78
AA47 Separation distress†	.71	AA49 Separation distress†	.77
AA49 Separation distress†	.71	AA50 Separation distress†	.74
AA50 Separation distress†	.70	AA47 Separation distress†	.50
AA48 Separation distress	.62		
Obsession (Factor 4)		Obsession (Factor 4)	
RL22 Intrusive thinking†	.82	RL13 Intrusive thinking†	.84
RL19 Longing for reciprocity†	.71	RL22 Intrusive thinking†	.70
RL13 Intrusive thinking†	.67	RL24 Action toward determining the other's feelings†	.53
RL24 Action toward determining the other's feelings†	.52	RL17 Desire to know and to be known†	.44
RL17 Desire to know and to be known†	.52	RL19 Longing for reciprocity†	.43
Adult attachment/Care-giving (Factor 5)		Adult attachment/Care-giving (Factor 6)	
AA41 Secure base†	.82	AA38 Safe haven†	.70
AA37 Safe haven†	.77	AA41 Secure base†	.68
AA35 Safe haven†	.72	AA37 Safe haven†	.66
AA38 Safe haven†	.69	AA35 Safe haven†	.58
		AA40 Secure base	.60
Sexual desire for others (Factor 6)		Sexual desire for others (Factor 2)	
SO65 Intensity†	.91	SO65 Intensity†	.89
SO62 Intensity†	.83	SO62 Intensity†	.88
SO66 Intensity	.74	SO63 Intensity	.86
		SO60 Frequency	.76

Note. Items with daggers are common items for the both groups. RL is romantic love, AA for adult attachment, and SP and SO for sexual desire for a partner and others respectively, in the original scale.

Invariance analysis. Next, a series of multi-group CFA were conducted to examine if the measurement model was invariant across the two groups. First, a test of configural invariance was performed with no constraints on factor loadings to determine if the factor structure was equivalent across the two groups. The chi-squared test provided the base line χ^2 values for the following step, χ^2 (388) = 654.96, $p < .001$. CFI (= .96) and RMSEA (= .03, 90% CI [.03, .04]) had acceptable values (> .90 and < .50, respectively), indicating good model fit across the groups. Having established the configural invariance, metric invariance was tested with factor loadings constrained to be equal across the groups. This step examines whether the magnitude of the factor loadings differs between the groups. The comparison between the baseline model, χ^2 (388) = 654.96, and the constrained model, χ^2 (404) = 688.95, was significant, χ^2 (16) = 33.99, $p < .01$. This indicated that the pattern of factor loadings was not equivalent across the groups.

To improve the measurement equivalence in terms of the magnitude of factor loadings, three items (13, 19, and 47) that showed the greatest difference in loadings between the two groups were examined. I experimented with removing these top three items one at a time and in series. By the removal of a single item (item 13) from the obsession scale, the difference between the baseline model, χ^2 (388) = 654.96, and the constrained model, χ^2 (403) = 677.59, became insignificant, χ^2 (17) = 22.63, *ns*. This indicated that factor loadings in the new model were invariant across the two groups. Table 11 shows the final version of the common scales after the deletion of the single item from the obsession sub-scale.

Third, I tested whether the pattern of inter-correlations between the factors was invariant across the groups. The comparison between the new constrained model (without item 13), χ^2 (403) = 677.59, and the third model, χ^2 (418) = 778.53, was significant, χ^2 (415) = 100.94, $p < .001$. This indicated that the correlations among the factors differed between the groups.

Table 11

Common Scale for the Japanese and Occidental Groups to Measure Six-Dimensions of Pair-Bond Relationships

Obsession
19 Longing for reciprocity–*I have an endless appetite for affection from my partner*.
17 Desire to know the partner and be known–*I yearn to know all about my partner*.
22 Intrusive thinking–*My partner always seems to be on my mind*.
24 Action toward determining the other's feelings–*I eagerly look for signs indicating my partner's desire for me*.
Care-receiving
27 Safe haven–*My partner helps me feel better when something bad happens to me, or I feel upset*.
29 Safe haven–*I feel that my partner understands me when I have a hard time*.
31 Secure base–*I can count on my partner, and I think my partner will always be there for me and care about me in times of need*.
33 Secure base–*I know that my partner senses when I have a problem and will support me*.
Care-giving
35 Safe haven–*I help my partner to feel better when something bad happens to him/her, or he/she feels upset*.
37 Safe haven–*I try to understand my partner when he/she has a hard time.*
38 Safe haven–*I would like to be with my partner when he/she feels sad.*
41 Secure base–*I try to sense if there is a problem with my partner and am willing to support her/him.*
Separation distress
12 Negative feelings when things go awry–*I would feel despair if my partner left me*.
47 Separation distress–*If I were separated from my partner, I would feel down or lonely*.
49 Separation distress–*My life would be severely disrupted if my partner was no longer a part of it*.
50 Separation distress–*If my partner was no longer accessible to me, I would feel greatly distressed*.
Sexual desire for a partner
54 Intensity–*When you see your partner, how strong is your sexual desire?*
57 Intensity–*How strong is your desire to engage in sexual activity with your partner?*
58 Intensity–*How important is it for you to fulfill your sexual desire through activity with your partner?*
Sexual desire for others
62 Intensity–*When you first see a person you find attractive (not your partner), how strong is your sexual desire?*
65 Intensity–*How strong is your desire to engage in sexual activity with a person you find attractive (not your partner)?*

Note. A number and sub-dimension of each item in the original scale are displayed at the left side of the table.

Table 12 displays the intercorrealtions for each of the six common scales for the Japanese group (n = 324) above the diagonal and for the Occidental group (n = 304) below the diagonal. A two-tailed Fisher's r-to-z transformation further tested between-group differences (i.e., the Occidental group versus the Japanese group) in the magnitude of these correlation coefficients. The most marked differences were found in the associations between sexual desire scales and other scales.

Regarding sexual desire for a partner, it was significantly and positively correlated to care-receiving (r = .24), separation distress (r = .38), and sexual desire for others (r = .50) in the Japanese group while these associations were not significant in the Occidental group. Fisher's r-to-z transformation showed that these associations, partner-directed sexual desire versus care-receiving (z = -3.10, p < .001), separation distress (z = -3.99, p < .001), and other-directed sexual desire (z = -7.22, p < .001), were significantly different between the Occidental and the Japanese groups.

Regarding other-directed sexual desire, it was significantly and negatively correlated to care-receiving (r = -.24), care-giving (r = -.33), and separation distress (r = -.21) in the Occidental group while these associations were not significant in the Japanese group. Fisher's r-to-z transformation showed that these associations, other-directed sexual desire versus care-receiving (z = -3.42, p < .001), care-giving (z = -4.40, p < .001), and separation distress (z = -2.69, p < .01), were significantly different between the Occidental and the Japanese groups.

In addition, obsession and separation distress showed a positive and large association in both groups, but the magnitude of the effect was greater in the Japanese group (r = .72) than the Occidental group (r = .52). Moreover, in the Japanese group obsession and care-receiving was positively associated with each other (r = .15, p < .001) whereas this correlation was not significant in the Occidental group. Fisher's r-to-z transformation showed that the correlation between obsession and separation distress was significantly different between the Occidental and the Japanese groups (z = -4.13, p < .001) while the difference in the correlation between obsession and care-receiving was not significant between the two cultural groups (z = -1.51, *ns*).

Table 12

Summary of Intercorrelations for the Six Common Scales as a Function of Cultural Group

Common scales	Obsession	Care-receiving	Care-giving	Separation distress	Desire: Partner	Desire: Others
Obsession		.15***	.45***	.72***	.47***	.03
Care-receiving	.03		.54***	.44***	.24***	.03
Care-giving	.46***	.63***		.47***	.30***	.01
Separation distress	.52***	.47***	.54***		.38***	.003
Sexual desire for a partner	.50***	-.004	.23***	.08		.50***
Sexual desire for others	-.07	-.24***	-.33***	-.21***	-.03	

Note. Intercorrelations for the Japanese group (n = 324) are presented above the diagonal, and intercorrelations for the Occidental group (n = 304) are presented below the diagonal. *** $p < .001$.

Internal Consistency for the Common Scales. Internal consistency for each of six sub-scales was computed for the two groups, separately. For the Japanese groups (n = 324), all subscales showed excellent reliability: *Obsession* (4 items: α = .80); *Care-receiving* (4 items: α = .88); *Care-giving* (4 items: α = .85); *Separation distress* (4 items: α = .82); *Sexual desire for a partner* (3 items: α= .85); and *Sexual desire for others* (2 items: α = .88).

For the Occidental groups (n = 304), subscales had good reliability except the obsession scale: *Obsession* (α = .71); *Care-receiving* (α = .85); *Care-giving* (α = .78); *Separation distress* (α = .81); *Sexual desire for a partner* (α = .80); and *Sexual desire for others* (α = .86).

In both groups, the obsession scale showed the lowest internal consistency. This might indicate that the deletion of the single item (13) from the obsession scale improved the measurement equivalence across the two groups at the cost of lower scale reliability.

Discussion

Dimensions of Pair-bond Relationships

Fisher (1998) proposed that sexual desire, romantic love, and adult attachment are evolved mechanisms to initiate and maintain pair-bond relationships. One of the main purposes of the present study was to empirically test whether the dimensions of pair-bond relationship are composed of the conceptual distinctions made by Fisher (1998). By using principal axis factor analysis (PAF), the study examined whether the 55 Likert-scale items (selected in Chapter Two) would show the predicted dimensions indicated by Fisher's hypothesis (1998) and attachment theory(e.g., Bowlby, 1969). Having established the underlying factorial structure, confirmatory factor analysis (CFA) was further used to refine the measurement items for each factor using diagnostic statistics.

Following this procedure, a series of factor analyses were conducted on the datasets of the Japanese and Occidental groups separately and these generated the six-factor solution for both groups. The analyses showed that the factor structures of the two groups were almost identical to each other. The items loading on each of these six factors were largely the same, and the same factor labels (*Sexual desire for a partner*, *Sexual desire for others, Obsession*, *Adult attachment care-receiving*, *Adult attachment care-giving*, and *Adult attachment separation distress*) could be used when naming these factors in each group. In the current study, the dimensions of pair-bond relationship were split into sexual desire-related factors (i.e., sexual desire for a partner and others), a romantic love-related factor (i.e., obsession), and attachment-related factors (i.e., care-receiving, care-giving, separation distress).

Sexual desire for a partner and others. Fisher (1998) hypothesized that sexual desire motivates individuals to desire sexual union with a member of opposite sex while romantic love leads them to focus their sexual and emotional interest on a preferred individual. One of the most important differences between romantic love and sexual desire may be that sexual desire can be directed towards a number of individuals while romantic love is usually directed exclusively to a particular individual (Fisher, Aron, & Brown, 2006). Accordingly, sexual desire was measured in two contexts: sexual desire for a person with whom one is in love and sexual desire for attractive others. As expected, two factors for sexual desire (sexual desire for a partner and others) were extracted in the present study. This might support the idea that sexual desire can be addressed multiple individuals, and it may converge on a particular individual when combined with romantic attraction towards this person.

Obsession. Although there were initially 15 items (from the Passionate Love Scale; Hatfield & Sprecher, 1986) taken from ten sub-dimensions of 'romantic love', in the present study the romantic love component was compressed to a factor characterized by longing for emotional union with a partner and intrusive thoughts about them. This fits well the views of other researchers who described 'romantic love' (or other equivalent terms for romantic love) as "a condition of cognitive obsession" (limerence; Tennov, 1979/1999, p.33), "a state of intense longing for union with another" (passionate love; Hatfield & Walster, 1978, p. 9), or "romantic love with obsession" (passionate love; Acevedo & Aron, 2009, p.62). It is also consistent with the definition of romantic love in the present study, 'an intense desire for emotional union with and possessive feelings towards a particular individual'. In line with Fisher's hypothesis, a state of obsession may direct and augment attention to a specific individual in order to form a pair-bond relationship. This obsession component may be the only one that is unique to pair-bond relationships, since sexual desire can be addressed to extra-pair partners (Fisher, 1998), and adult attachment can be, for instance, peer- or family-oriented (Hazan & Zeifman,

1994).

Adult attachment: Care-receiving, care-giving, and separation distress. Attachment theory (e.g., Ainsworth, 1967; Bowlby, 1969), as initially developed to explain in infant-caregiver bonds, proposed that infants have an instinctive attachment system leading them to attach to their caregivers, while adults have an instinctive care-giving system driving them to provide protection and support to their infants. The common goal of these coordinated systems is the maintenance of close bodily contact between a parent and a child to keep infants from danger. In terms of infants' attachment system, the key components are *proximity seeking*, *separation distress*, *safe haven*, and *secure base* (Ainsworth et al., 1978; Bowlby, 1988). In healthy attachment relationships, infants know their care-givers are available for their needs (i.e., care-givers as a secure base), and they seek proximity to their care-givers (i.e., care-givers as a safe haven) under stressful conditions to gain comfort (Ainsworth, 1967).

These functions of the adult attachment system are proposed to be equivalent to the functions of infant attachment system (Hazan & Shaver, 1987), because mental models developed via interaction with care-givers in childhood continue to influence social interactions in adulthood (Bowlby, 1969). However, these two forms are not identical since adult attachment is generally a two-way street (Hazan & Shaver, 1987). This mutuality means there is no fixed 'giver' or 'receiver' role. Hence, one can play both a care-receiver and care-giver simultaneously in adult attachments (Hazan & Shaver, 1987, 1994; Weiss, 1982). In this vein, safe haven and secure base were each measured from both a care-receiver and care-giver's perspective in the current study.

One of the notable results in the present study is that care-receiving and care-giving appeared as separate factors, with items assessing safe haven and secure base subsumed within them. This indicates that care-receiving and care-giving are distinguishable facets of the attachment relationship as others have suggested (e.g., Ainsworth, 1985; Vormbrock, 1993) and in adult attachment relationships one can play both (or either) a care-giver and care-receiver (Weiss, 1982), probably at different points and different contexts. On the one hand, care-receiving and care-giving were positively and moderately correlated (in both cultural groups), implying that one may not unconditionally give or receive care from a partner. This implies that in adult attachment relationships, unlike in infant-caregiver relationships, the act of mutual care-giving and care-receiving may contribute to the establishment of attachment bonds.

Another finding in the present study is that proximity seeking, one of the key attachment components, was not extracted. The absence of a proximity seeking factor in the present study suggests that the main function of the adult attachment system may not be necessarily the maintenance of proximity with attachment figures, or that it is less important in adult than infant attachment relationships. One of the possible explanations

is that developmental differences between infants and adults. That is, compared to infants, adults are psychologically (and physically) more mature, and thus able to handle stressful conditions more efficiently than infants. For instance, infants might need actual close physical contact with care-givers to feel secure while older children and adults may be able to gain comforts from attachment figures through other means, such as phone calls, expectations of future contact, or even mental images of them (Hazan & Zeifman, 1994).

However, this is not to say that proximity seeking is completely absent in adult attachment relationships. Sudden or extended period of separation from attachment figures do activate distress and in turn proximity seeking behaviours (Fraley & Shaver, 1998; Weiss, 1988). Indeed, the present study extracted a separation distress component, implying that adults may not actively seek proximity but are fearful of future or permanent separation. This indicates that separation distress may function as the activation of attachment behaviours (including proximity seeking behaviours) in response to stressful conditions in adult attachment systems as well. Nevertheless, proximity seeking may necessarily not a primary mean of gaining comfort in adult attachment relationships. This is because adults, compared to infants, might have more options to feel secure in addition to seeking close physical contacts (Hazan & Shaver, 1994).

Constructions of the Common Scales to Assess Pair-Bond Relationship Dimensions

The present study also constructed the common self-report scales for the Japanese and Occidental groups to measure the six dimensions of pair-bond relationships. These common scales will to be used in the subsequent analysis when individual and cultural differences (the Japanese and Occidental groups) are addressed (Chapter Four). The common scales were constructed by using 22 items showing common loading on the six factors generated by the culture-specific PAFs and CFAs.

Multi-group CFA was conducted to assess measurement equivalence of the common scales across the two groups, and it showed that the factorial structure was equivalent between the two groups. Moreover, the factor loadings of the scale items were also invariant across the two groups after the deletion of the single item from the obsession scale. These results indicate that, in terms of the factor structure and item loadings, there was no marked cultural difference between the two groups in the present study. The final common scales were composed of 21 items across the six scales: obsession (four items); care-receiving (four items); care-giving (four items); separation distress (four items); sexual desire for a partner (three items); and sexual desire for others (two items). In terms of reliability, although the obsession scale for the Occidental group had the lower than desirable internal consistency ($\alpha = .71$), all other scales showed good internal consistency for the Japanese and Occidental groups ($\alpha \approx .80$).

However, multi-group CFA further showed that inter-correlations between the six scales were not equivalent across the two groups. This indicates that there are cultural differences in the associations between the dimensions of pair-bond relationships. Indeed, some of correlations between relationship dimensions were significantly different between the Occidental and the Japanese groups, in which the most marked differences were found in the correlations relative to sexual desire dimensions. In the Occidental group, sexual desire for others showed significant and negative correlations with attachment-related dimensions (care-receiving, care-giving, and separation distress). The correlation between partner-directed sexual desire and other-directed sexual desire was not significant, suggesting that these are dissociable aspects of sexual motivation. However, correlations between other-directed sexual desire and attachment-related dimensions were more substantial. These negative associations fit well with Fisher's hypothesis (1998) which suggested that attachment functions to maintain the exclusivity of pair-bond relationships.

However, this pattern of correlations was not present in the Japanese group. Other-directed sexual desire showed non-significant correlations with all the other five dimensions, except for its significant and positive associations with sexual desire for a partner. The weak associations between other-directed sexual desire and obsession and attachment-related components suggest that partner-oriented romantic and attachment feelings do not impact on sexual attractions toward others in the Japanese group. In addition, the more substantial positive association between partner-directed and other-directed sexual desire implies that the intensity of sexual desire may not be specific to a particular target but may reflect an individual difference variable of lower or higher general sexual drive. Since the demographic features were adjusted to be similar between the Occidental and Japanese groups, the differences found between the two groups could be due to cultural invariance. The cultural dimension theory (Hofstede, 1980) might be able to explain why partner-directed and other-directed sexual desire were uncorrelated in the Occidentals but correlated in the Japanese, and why attachment-related dimensions negatively associated with other-directed sexual desire in the Occidentals but uncorrelated in the Japanese. It was suggested that sexual behaviours are experienced as "a way of performing" in masculine societies whereas they are experienced as "a way of relating" in feminine societies (Hofstede, 2001, p.328). Indeed, a study showed that a positive association between sexual attraction and romantic feelings were weaker in a masculine society than in a feminine society (Foa et al., 1987). Consequently, this more masculine characteristic of the Japanese group (relative to the Occidental group) might have been reflected in the non-significant relations between other-directed sexual desire and partner-oriented feelings (obsession and attachment dimensions). Nevertheless, in line with Fisher's hypothesis (1998), partner-directed sexual desire showed a medium to

large positive associations between romantic and attachment-related dimensions. This indicates that, although obsession and attachment-related dimensions may not decrease sexual attraction toward others in the Japanese group, these components may be associated with partner-directed sexual desire and thus contribute to the maintenance of relationships.

Limitations and Conclusion

The present study attempted to identify factors underlying pair-bond relationships and to construct internally consistent self-report scales to measure these dimensions in Japanese and Occidental groups. It has to be noted that exploratory factor analysis only produces a factor structure particular to a population used in analyses, and the replication of the produced factor-structure in different samples is often very difficult (Osborne, Fitzpatrick, & Carolina, 2012). The replicability of factors may be affected by various elements, including the selection of individuals (Gorsuch, 1983). It is possible that a different factor structure can emerge if a sample with different characteristics is used. This suggests that in order to make comparison between the Japanese and Occidental groups, the characteristics of each sample should be ideally the same or at least similar to each other (Minkov, 2013; van de Vijver & Leung, 1980; van de Vijver & Leung, 1997). When demographic features were similar between the two cultural groups, the dimensions of pair-bond relationships (obsession, care-receiving, care-giving, separation distress, partner-directed and other-directed sexual desire) were shown to be invariant across the two groups in terms of their factor number and the items loading on them. Good replicability across different samples provides positive evidence that the six factor model and the dimensions of pair-bond relationships may be robust between cultures. This results are consistent with hypothesis that mechanisms underlying pair-bond relationships are a human universal (Fisher, 1998). On the other hand, even characteristics of the two samples were adjusted to have similar demographic profiles, cultural differences were found in the correlations between the six factors, especially among sexual desire factors. This may indicate that humans may share the sets of common mechanisms relative to the formation and maintenance of pair-bond relationships, but they may be flexible and adjusted to cultural norms or beliefs. In the next chapter, I used the common scales constructed in this chapter to examine the effect of cultures in relation to participants' sex and relationship status.

Chapter Four

The Effects of Culture, Sex, Age, and Relationship Stage

Introduction

In the previous chapter, the common dimensions of pair-bond relationships were identified for the Japanese and Occidental groups. These relationship dimensions were sexual desire-related dimensions (sexual desire for a partner and others), a romantic love-related dimension (obsession), and adult attachment-related dimensions (care-receiving, care-giving, separation distress). The present study examined whether these six self-reported relationship variables differed as a function of participants' age, relationship status, sex, and cultural background.

Dynamics of Pair-Bond Relationship

Fisher (1998) hypothesized that sexual desire motivates desire for sexual union with a member of the opposite sex, romantic love leads an individual to focus their sexual and emotional interest on a preferred mate, and adult attachment functions to maintain the exclusivity of the pair-bond relationship. Her approach suggests that each affective dimension may serve a distinct function in the formation and development of the pair bond over the course of relationships. Certainly, the nature of pair-bond relationships is subject to change over time (Berscheid, 2010). Each pair-bond dimension might be sensitive to key relationship events so that the intensity of relationship dimensions experienced by each individual may change with important transition points such as aging or having children (e.g., Berscheid, 2006, 2010). One of the main aims of the present study was to examine which factors are associated with changes in relationship dimensions. Using a life history framework, the present study attempted to examine how and why key factors might affect the quality of pair-bond relationships. Relationship stage is a factor that has often been mentioned in studies of romantic love (e.g., Acker & Davis, 1992; Gao, 2001). In addition to relationship stage, the current study also tested whether age and sex may affect the nature of pair-bond relationship dimensions, as well as examining cultural differences.

A life history framework can suggest potential factors which may alter the dynamics of pair-bond relationships. The theory proposes that since available resources (e.g., energy) and the life span of each organism are finite, allocation of resources to each life history task often involves trade-offs, including mating effort and parental effort (reviewed in Kaplan & Gangestad, 2005). According to life history theory, individuals need to make allocation decisions (either conscious or unconscious) about the trade-off between mating and parental effort in order to maximize fitness in specific circumstances. Adaptive conditional adjustment is one form of phenotypic plasticity, and its outcomes

might be a source of non-heritable individual differences (Penke, 2010). Adaptive conditional adjustment enables individuals to respond to current environments or circumstances and to adjust their life history strategies flexibly (Penke, 2009). Hence, the expressions of universal adaptations (e.g., the pair-bond mechanisms) can differ depending on contexts such as life history stage or local conditions (Tooby & Cosmides, 1990). Any factor which affects one's allocation decision about mating and parental effort may also change the dynamics of relationship dimensions.

Informed by this life history perspective, the relationship dimensions were expected to be differentially associated with mating and parental effort. If the six dimensions of pair-bond relationships were conceptually integrated into the trade-off between mating and parenting, attachment-related dimensions (care-receiving, care-giving, and separation distress) were predicted to be positively associated with parental effort. Predictions regarding sexual desire were more contentious due to the ambiguity of the term 'mating effort'. The term was defined as effort to obtain sexual partners (Low, 1978) without specifying whether partners were pursued as long- or short-term mates. On the other hand, parental effort was defined as effort to *produce* and raise offspring and other kin (Low, 1978). To avoid conceptual confusion, I divided mating effort into two types: mating effort in a pair-bond relationship context and mating effort in a short-term (i.e., uncommitted) relationship context. Thus, in the present study partner-directed sexual desire was viewed as pair-bond mating effort and other-directed sexual desire as short-term mating effort. Furthermore, if romantic love (i.e., obsession) functions to limit sexual desire to a specific partner, obsession and partner-directed sexual desire are expected to be closely tied to each other (Fisher, 1998). Indeed, the previous factor analysis (Chapter Three) showed that there was a positive association between obsession and partner-directed sexual desire in both cultures. This suggested that partner-directed sexual desire, as well as obsession, could be associated with pair-bond mating effort. Using the life history framework, this study examined whether age and relationship stage affected experiences of the pair-bond relationship dimensions.

Age. Fertility declines with age in both sexes, although more dramatically so for women (Balasch, 2010; Dunson, Baird, & Colombo, 2004; Hassan & Killick, 2003; Kovac et al., 2013; Wallace & Kelsey, 2010). The negative associations between age and fertility might imply that younger individuals, compared to older individuals, may allocate more to mating effort (sexual desire and obsession) than parental effort (attachment). Indeed, several studies on a large-dataset showed that sexual desire declines with age for both men and women (Bacon et al., 2003; Hayes & Dennerstein, 2005; Mitchell, Mercer, Wellings, & Johnson, 2009; but see Kontula & Haavio-Mannila, 2009) although lower sexual desire in older individuals might be associated with the increased prevalence of health problems (Lindau & Gavrilova, 2010).

In the current study, other-directed sexual desire was expected to be associated with short-term mating effort. If younger individuals tend to invest in mating effort over parenting effort, pursuing for a suitable mate for reproduction might be a higher priority for the young than the old. Thus, younger individuals, compared to older individuals, were expected to show greater sexual interests towards others in order to increase numbers of partners and/or opportunities for gaining better partners. Obsession and partner-directed sexual desire were conceptualised as elements of pair-bond mating effort. They were expected to be closely linked as romantic love was hypothesized to restrict one's sexual desire to a specific partner (Fisher, 1998). Data presented in Chapter Three confirmed significant positive correlations between these two measures. However, these same data indicated that, contrary to expectation, obsession and other-directed sexual desire were not negatively correlated. This implies that short-term mating effort and pair-bond mating effort do not have an inverse relationship. Based on this, in addition to other-directed sexual desire, younger individuals were expected to show greater obsession and partner-directed sexual desire than older individuals due to their predicted tendency to favour mating effort over parenting effort.

Relationship stage. The course of pair-bond relationships in contemporary societies often involves individuals' conscious decisions (e.g., to marry, to have a child) which propel relationships into more serious stages. Such decisions themselves may be responsive to changes in the affective quality of the relationship such that there is a bi-directional relationship. In either case, relationship stage was shown to be a strong factor which affects the mean levels of relationship dimensions (Acker & Davis1992; Gao, 2001). Fisher (1998) indicated that the presence of a child might be a key factor in altering the dynamics of pair-bond relationships. Thus, for this study, relationship stages were divided into four categories: *(1) one-sided love*; (2) *dating*; (3) *engaged, cohabiting, or married with no child*; and (4) *engaged, cohabiting, or married with one or more children*. Individuals in the 'one-sided love' stage were in love but they were not in a relationship with the beloved or the beloved did not know about their amorous feelings. Individuals in the 'dating' stage were in relationships with the beloved partners. Individuals in the 'engaged, cohabiting, or married with no child' stage were deeply involved with their partners but did not yet have children with them. Individuals in the 'engaged, cohabiting, or married with one or more children' stage were mutually involved and had already had children with their partners.

Individuals at various life stages may deal with the trade-off between mating and parenting effort differently if primary life history tasks change over the course of pair-bond relationships. For instance, individuals at more committed relationship stages (engaged, cohabiting, married) might allocate more energy to preparing for parental effort (care-receiving, care-giving, separation distress) than individuals at less serious

relationship stages (one-sided love, dating). Indeed, a study showed that commitment towards partners increased when relationships formally entered more serious stages (e.g., unmarried to married) (Acker & Davis, 1992). According to Fisher (1998), adult attachment strengthens the pair-bond to support successful child rearing. According to this view, adult attachment was expected to correlate positively with parenthood. Therefore, levels of attachment dimensions (care-receiving, care-giving, separation distress) were expected to increase after having children. Moreover, individuals at the parental stage may shift their primary life history task from mating to parenting. This shift implies that parenthood might be inversely associated with mating effort. Therefore, individuals at the parental stage were predicted to show lower partner- and other-directed sexual desire. For example, levels of testosterone, which might be associated with sexual desire (e.g., van Anders & Dunn, 2009; but see also van Anders, 2012), were shown to be lower in mothers and fathers than men and women without children (Gray, Yang, & Pope, 2006; Kuzawa, Gettler, Huang, & McDade, 2010).

Sex differences. Pair-bond relationship mechanisms can be viewed as universal adaptations (Penke, 2010), but the expressions of these adaptations is expected to have different settings in men and women (Tooby & Cosmides, 1990). The conventional sex role argument (e.g., Trivers, 1972) predicts that, for men, increasing the number of sexual partners may often be more beneficial than maintaining pair-bond relationships due to their smaller initial reproductive cost. Thus, men, compared to women, are likely to invest relatively more in short-term mating effort than in parental effort (Buss & Schmitt, 1993). This has been supported by a considerable body of data indicating that men have evolved a higher sex drive and prefer a larger number of sexual partners than women (Baumeister, Catanese, & Vohs, 2001). Men's higher sex drive further predicts that men invest more mating effort (sexual desire) both in a pair-bond context and a short-term context than women. On the other hand, the conventional sex role argument predicts that women, compared to men, tend to invest more in parental than mating efforts due to their heavier obligate parental investment and reproductive cost (Buss & Schmitt, 1993). Based on this and on previous research on sex differences in sexual desire (Baumeister et al., 2001), it was predicted that sexual desire for partner and others (associated with mating effort) would be higher in men than women, while adult attachment (associated with parental effort) would be higher in women than men.

The conventional sex role perspective implies that patterns of the association between relationship stage and the relationship dimensions may differ across sexes. The attachment-related dimensions of the pair bond (associated with parental effort) were expected to be positively associated with parenthood. The traditional sex role view of 'caring' females (Darwin, 1871) suggests that females allocate more to parental than mating efforts. If this is the case, the magnitude of the positive associations between

parenthood and adult attachment dimensions was expected to be stronger for women than men. This in turn may be reflected in the amount of perceived care-giving by fathers to their partners (i.e., care-receiving by mothers) (Note that, in the current study, care-receiving represented the amount of care-giving which individuals reported receiving from their partners, and in couples with children both partners were at the parental stage). Thus, the positive associations between parenthood and partner-directed care-giving and separation distress were expected to be stronger for women, whereas the positive association between parenthood and care-receiving was predicted to be stronger for men. Furthermore, if men, relative to women, invest in short-term mating effort more than in parental effort, they may be more motivated to seek extra-pair partners after having a child. Thus, a negative association between parenthood and other-directed sexual desire is predicted to be weaker for men.

Cultural differences. Although universal adaptations may generate predictable patterns in some behaviours, individuals are able to response flexibly to their current environment (Penke, 2010). One of the strongest environmental factors which may modulate universal adaptations is culture (Cashdan, 2013). Culture, as understood by evolutionary psychologists, is socially-transmitted information which may affect individuals' behaviours (Boyd & Richerson, 2005). A cultural variant (i.e., a unit of cultural transmission) may be transmitted through various routes (e.g., from parents to offspring or from peer to peer; Cavalli-Sforza & Feldman, 1981) in different transmission forms (e.g., teaching and imitation; Boyd & Richerson, 2005) and via different media (e.g., social interaction, television, internet). Cultural differences can arise from differential initial production of cultural variants (as a result of ecological pressure), from different population biases in uptake (including conformity bias, prestige bias and content-based bias, i.e., the inherent attractiveness of cultural variants), as well as from random sources such as cultural drift (Boyd & Richerson, 1985; Claidière & Sperber, 2007; Laland & Brown, 2002). Because uptake is enhanced by the degree of 'fit' between new variants and already installed cultural beliefs or practices, culture can become self-reinforcing (Durham, 1991). These cultural transmission processes may ultimately produce cultural traits specific to a population or at least more common in some populations than in others. Although the previous factor analysis study (Chapter Three) showed that the six dimensions underlying pair-bond relationships were structurally invariant across the Japanese and the Occidental groups, the typical values on these dimensions and the way in which the dimensions are related to relationship variables may be flexible and adjusted to cultural norms or beliefs (e.g., Fisher, 1998). Thus, one of the aims of the current study was to examine whether there are cultural differences in experiences of the pair-bond relationships between the Japanese and the Occidental groups. Moreover, as discussed in Chapter One, theories and hypotheses of

pair-bond mechanisms have been mainly developed by Western researchers with samples recruited in Western countries. Therefore, the present study also aimed to test the applicability of these theories and hypotheses in a non-Western culture (i.e., Japan).

Two of Hofstede's (1980) cultural dimensions, *individualism-collectivism* and *masculinity-femininity*, can be applied to the understanding of possible cultural differences in experiences of pair-bond relationships. According to Hofstede, cultural dimensions represent 'dominant' patterns of thinking in a population that can produce societal-level norms in various contexts (e.g., familial, educational, and political structures). This dimensional model attempts to describe differences in 'values' (i.e., "broad tendencies to prefer certain states of affairs over others"; Hofstede, 1991, p. 263) at the level of society rather than the individual. Thus, it is important to keep in mind that the cultural dimensions do not predict that every individual in a certain culture will show the same preferences. The individualism-collectivism dimension describes "the degree to which people in a society are integrated into groups" (Hofstede, 2011, p.11). In individualist societies, relations between individuals are not tightly bound and individuals are expected to take care of themselves and close family members only. By contrast, in collectivist societies, individuals are integrated into cohesive social groups (e.g., extended family) which form a core aspect of their personal identity. A key difference between individualist and collectivist societies lie in conceptions of individuality in which the former emphasizes independence and autonomy, and the latter places a higher value on connectedness and interdependence among individuals (Markus & Kitayama, 1991). In individualist societies, one's sense of self is detached from the surrounding social context, while in collectivist societies it is inseparable from that context (Markus & Kitayama, 1991). In collectivist societies, the strong connectedness within group members may divide intimacy between them, resulting in lessened intimacy towards a romantic partner (Dion & Dion, 1988). This suggests that feelings towards partners within pair-bond relationships are more intense in individualistic societies than in collectivist societies.

A second key dimension is the extent to which a society is 'masculine' or 'feminine' (Hofstede, 1980, 1998). In masculine societies, gender roles are very distinct so that men are expected to be assertive and value material success, while women are expected to be modest, caring, and to be concerned with relationships. In feminine societies, both men and women are expected to be exhibit more 'feminine' traits (e.g., modesty). Most relevant to the present study, pair-bond relationships and parenthood are valued more in relatively feminine than masculine societies (e.g., Simmons, Kolke, &Shimizu, 1986;Van Yperen & Buunk, 1991). This further implies that sex differences in the pair-bond relationship context might be relatively greater in more masculine societies. In more masculine societies, men are expected to value relationships less than

women, and women are expected not to be sexually active. The magnitude of these sex differences are expected to be smaller in more feminine societies (Hofstede, 1998).

The dimensions of individualism-collectivism and masculinity-femininity can be reflected in cultural differences which may strongly affect individual experiences (Hofstede, 1980; Hofstede et al., 1998; Markus & Kitayama, 1991). A comparative study showed that Japan is more collectivistic than Western countries (Hofstede et al., 2010). Regarding the masculinity-femininity dimension, masculinity was shown to be highest in Japan and German-speaking countries, medium in English-speaking Western countries, and much lower in Nordic countries and the Netherlands (Hofstede et al., 2010). Given the fact that 65% of the Occidental group in the present study was composed of English-speaking Western countries, it is reasonable to conclude that the Occidental group was exposed to a relatively more feminine culture than the Japanese group. In summary, Japanese participants were expected to have experienced and internalised a more collectivistic and masculine set of cultural values, and Occidental participants more individualistic and feminine values.

The characteristics of individualist-collectivist societies (i.e., diffused intimacy in collectivist societies) and masculine-feminine societies (i.e., less focused attention on relationships and parenthood in masculine societies) imply that partner-directed feelings (obsession and attachment) and sexual desire may be more intense in the Occidental than the Japanese groups. This has been supported by previous cross-cultural research. Japanese participants perceived terms (e.g., lover, spouse) related to opposite-sex relationships as less intimate than Americans (Gudykunst & Nishida, 1986); they valued romantic relationships less than Americans and Germans (Simmons et al., 1986); they were less passionate (e.g., beliefs in love at first sight, idealization of a partner) than Americans and Russians (Sprecher et al., 1994); and the extent of commitment and disclosure to romantic partners was lower in Japanese than Americans and French (Ting-Toomey, 1991).

In addition, the characteristics of masculinity-femininity society (i.e., the gap between sexes is wider in more masculine societies and women are expected to be less sexually active) imply that the magnitude of expected sex differences in the pair-bond dimensions (i.e., higher sexual desire in men and higher attachment in women) may be greater in the Japanese than the Occidental groups. Mixed evidence has been found for this point. For example, a large cross-cultural study based on college samples (Schmitt, 2003a) showed that in some countries men were more inclined to avoid close relationships than women. Regarding Western and East Asian countries, the magnitude of the effect was larger in Japan than in Britain (in line with the cultural dimension theory), but the effect size varied between small to medium in both Western countries and East Asian countries. Moreover, in some of these countries, there was no statistically

significant sex difference (e.g., China, France). In light of the cultural dimension theory (Hofstede, 1980) and previous research, the current study attempted to explore effects of culture on pair-bond relationship dimensions, and the interaction of culture with other variables (age, relationship length and stage, and sex).

The Current Study

The main goals of the present study were to examine whether the factors of age, relationship stage, sex and culture affect mean levels of the pair-bond relationship dimensions (obsession, care-receiving, care-giving, separation distress, partner-directed and other-directed sexual desire) reflecting mating and parenting effort. Below is the summary of main predictions.

Age is negatively associated with fertility; thus, mating-related dimensions may be a higher priority in younger than older individuals.

1. Younger participants, compared to older participants, will show greater other-directed sexual desire.
2. Younger participants, compared to older participants, will show greater partner-directed sexual desire and obsession.

Individuals at various *relationship stages* may resolve the trade-off between mating and parenting effort differently if primary life history tasks change over the course of pair-bond relationships.

3. There will be negative association between parenthood and the level of other-directed sexual desire.
4. The levels of adult attachment (care-receiving, care-giving, separation distress) will increase with the progress of relationship stages (from 'one-sided love', 'dating', to 'engaged, cohabiting, or married').
5. There will be positive associations between parenthood and the levels of adult attachment (care-receiving, care-giving, separation distress) and a negative association between parenthood and the level of partner-directed sexual desire.

The expression of pair-bonding mechanisms may have different settings in the two *sexes*. The classic sex role perspective predicts that men may allocate more energy to mating effort (within and beyond the pair-bond) while women may allocate more to parental effort.

6. Men, compared to women, will show greater sexual desire for a partner and others, and lower adult attachment (care-receiving, care-giving, separation distress).

In addition, there may be sex differences in the effect of relationship stages on the relationship dimensions.

7. The negative association between parenthood and other-directed sexual desire will be weaker for men than women.
8. The positive associations between parenthood and care-giving/separation distress will be stronger for women than men (and as a result men with children will show more care-receiving).

Culture may influence individuals' pair-bond relationship experiences, and the broad cultural dimensions of individualism-collectivism and masculinity-femininity may help to interpret cultural differences in pair-bond relationships. In the present study, Japanese participants were expected to be relatively more collectivistic and masculine and Occidental participants to be more individualistic and feminine.

9. Partner-oriented obsession, adult attachment (care-receiving, care-giving, separation distress) and sexual desire will be stronger in the Occidental than the Japanese groups.
10. The magnitude of expected sex differences in the pair-bond dimensions (see Prediction 6) will be greater in the Japanese than the Occidental group.

Method

Participants and Data Collection

Participants were the same as those used in the previous factor analyses study (Chapter Three). In the previous chapter, the Japanese and the Occidental groups were adjusted to have similar demographic profiles, but in the present study, all participants were included. The original sample was composed of 931 men and women over 18 years old who joined the study voluntarily. The sample was reduced to 873 after excluding participants who had missing data or did not fit the four relationship categories in the present study. Of the remaining sample, there were 619 females (M_{age}= 28.82year-old, MD_{age} = 23.00, SD = 12.17, 95% CI [27.86, 29.78]) and 254 males (M_{age} = 28.18 year-old, MD_{age} = 21.50, SD = 13.37, 95% CI [26.53, 29.83]) aged between 16 and 73 year-old. Relationship length ranged from one week to 44.31years (M_{length}= 5.14 years, MD_{length}= 1.85 years, 95% CI [4.58, 5.71]). The percentage in each relationship status was as follows: 'Not in a relationship or one-sided love' (22.11%); 'Dating' (42.84%); 'Cohabiting, engaged, or married and with no child' (23.83%); and 'Cohabiting, engaged, or married and with one or more children' (11.23%). Regarding cultural backgrounds, 44.56% of participants reported themselves as Japanese and 55.44% as Occident (British = 297, European = 172, North American = 14, Oceanian = 1).

Measures

Pair-bond relationship scale. Appendix D displays the six sub-scales used to measure the dimensions of the pair-bond relationship which were identified in the previous factor analyses study (Chapter Three). The scale was composed of 21 items that were designed to assess the six relationship dimensions: *Obsession* (four items); *Attachment care-receiving* (four items); *Attachment care-giving* (four items); *Attachment separation distress* (four items); *Sexual desire for a partner* (three items); and *Sexual desire for others* (two items). Participants were instructed to think about a person with whom they were currently in love or had been in love with in the past. They rated how true the 21 statements were using a 5-point scale for obsession and attachment-related items (from 1 = 'Disagree strongly' to 5 = 'Agree strongly') and an 8-point scale for sexual desire items (from 1 = 'No desire' to 8 = 'Very strong desire'). The raw scores on each item in the measures were summed and averaged to create a single variable for each of six scales.

Overview of Statistical Analyses

In the previous chapter, the Japanese and the Occidental groups were adjusted to have similar demographic profiles, but in the present study, all participants (except individuals who had missing data or did not fit the relationship categories) were included. Due to the change in the samples' composition, the model fit and internal consistency were examined again. Confirmatory factor analysis (CFA) was used to test how well the six factor conceptualization of pair-bond relationships fitted the current data. Internal consistency for each subscale derived from the factor analyses was assessed by using Cronbach's alpha (Cronbach, 1951). An α value around .80 is the commonly accepted desirable value for internal consistency (e.g., Bland & Altman, 1997; Streiner, 2003).

The participants' scores on the six dimensions were subjected to an analysis of covariance (ANCOVA) to examine the effects of age, relationship stage, sex, and culture (Japan and Occident). Relationship length was used as a covariate, because it was correlated with and constrained by age and relationship stage (correlation between length and stage: $r = .59$, $p < .01$; length and age: $r = .50$, $p < .01$; stage and age: $r = .50$, $p < .01$). Two-way interaction effects between each of the independent variables were examined, and separate ANCOVA was conducted to follow up interaction effects. Three-way interaction effects were not tested as the number of cases per cell became too small in some cases. As there were a large number of analyses, only significant effects are identified and discussed. In addition, an interaction effect between age and relationship stage was not interpreted since the number of cases per cell in the '22-34 year-old' group was too small ($n = 8$) and there was no parent in '16-21 year-old' group. It should be noted that the six relationship dimensions were analysed separately. However, the

dimensions were themselves correlated. Correlations ranged in size from r = -.09 (obsession and sexual desire for others) to r = .62 (obsession and separation distress).

Results

Confirming the Factor Structure

A six-factor structure (obsession, care-receiving, care-giving, separation distress, and sexual desires for a partner and others) was tested to see how well the structure fitted the present data (allowing for correlated factors). The comparative fit index (CFI = .97) and the goodness of fit index (GFI = .96) were above the .90 threshold, which indicated that the model fit was good (Hu & Bentler, 1999). Root mean square error of approximation (RMSEA = .04 with 90% CI [.04, .05]) was below the .06 threshold, indicating acceptable model fit (Browne & Cudeck, 1992). The chi-squared test of goodness-of-fit showed that the model and data were significantly different, χ^2 (174) =, 434.17, $p < .001$. However, chi-squared is generally recognised to be an over-stringent fit criterion being highly sensitive to sample size (Albright & Park, 2009; Jöreskog, 1969). These results suggested that the observed data acceptably fitted the six-factor model.

Scale Reliabilities

Internal consistency for each of six sub-scales of the pair-bond relationship measure was computed (N = 873). All subscales showed good reliability: Obsession scale (four items: α = .81); Care-receiving scale (four items: α = .89); Care-giving scale (four items: α = .85); Separation distress scale (four items: α = .86); Sexual desire for a partner scale (three items: α = .86); and Sexual desire for others scale (two items: α = .87).

Effects of Age, Relationship Stage, Sex, and Culture on the Pair-Bond Dimensions

Each of six dimensions were subjected to ANCOVA (with relationship length as a covariate) to test the effects of *age*, *relationship stage*, *sex*, and *culture* (Japan and Occident). There were three categories for age (16-21 years; 22-34 years; 35 or more years), and four categories for relationship stage (One-sided love; Dating; Engaged, cohabiting, married without a child; Engaged, cohabiting, married with one or more children). Prior to undertaking the analyses, the assumptions for ANCOVA were checked. For every analysis, the assumption of normality and homogeneity of regression slopes were met. However, in some cells the assumption of homogeneity of variance was violated and sample sizes were unequal. This might have affected test results. Means reported were adjusted for the covariate. An overall summary of the results are displayed in Table 13at the end of the result section.

Obsession. Outliers were identified, and the total sample size decreased from 873 to 870. Regarding the effect of culture, the Japanese group was predicted to score lower on obsession than the Occidental group (Prediction 9). As predicted, there was a significant main effect of culture on obsession, $F(1, 845) = 138.43$, $p < .001$, $d = 0.79$, on which the Occidental group ($n = 481$, $M = 3.91$, $SE = 0.05$, 95% CI [3.81, 4.01]) scored significantly higher ($p < .001$) than the Japanese group ($n = 389$, $M = 3.04$, $SE = 0.06$, 95% CI [2.92, 3.16]).

There was also a significant interaction between sex and age on obsession, $F(2, 845) = 3.73$, $p < .05$, $d = 0.17$ (Figure 1). Table 1 displays means, standard errors, and 95% confidence intervals of scores on the obsession scale for each age group as a function of sex. A main effect of age on obsession was tested for the two sexes separately. For women, the main effect of age was significant, $F(2, 614) = 4.32$, $p < .01$, $d = 0.23$, and pairwise comparisons showed that the middle age ('22-34 year-old') group scored significantly higher than the youngest ('16-21 year-old') group ($p < .01$) and the oldest ('35+ year-old') group ($p < .05$). There was no significant difference between the youngest and oldest age groups. As can be seen in Figure 1, women's higher scores 'peaked at the middle age group. This finding did not support Prediction 2, in which younger participants were expected to score higher on obsession than older participants due to their predicted tendency to favour mating effort (e.g., obsession) over parenting effort. For men however, the main effect of age was not significant, $F(2, 248) = 1.21$, *ns*. This might be because men do not have the constraint of the menopause. In addition, comparisons between the sexes showed that women scored significantly higher than men in the two younger age groups, the '16-21' group, $F(1, 385) = 7.26$, $p < .01$, $d = 0.27$ and the '22-34' group, $F(1, 262) = 7.52$, $p < .01$, $d = 0.34$, but not in the oldest '35+' group, $F(1, 214) = 0.30$, *ns*.

Figure 1

Estimated Marginal Mean Scores of Obsession for Each Age Group by Sex

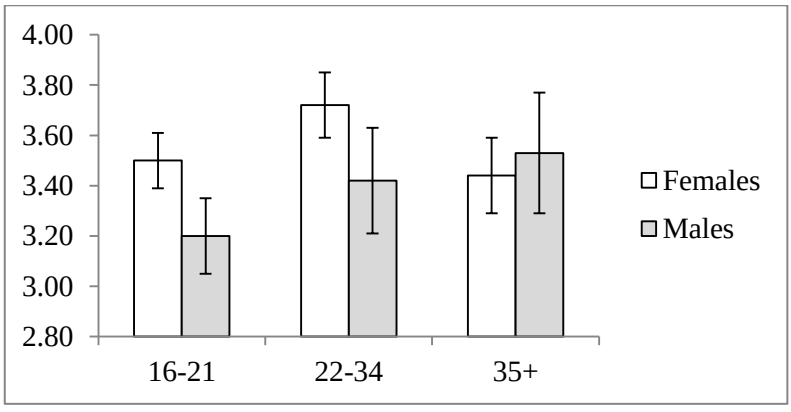


Table 1

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Obsession Scale for Each Age Group by Sex

			Females	
Age	*n*	*M*	*SE*	95% CI
16-21 year-old	261	3.50	0.06	3.39, 3.61
22-34 year-old	195	3.72	0.06	3.60, 3.85
35+ year-old	162	3.44	0.08	3.29, 3.60
			Males	
16-21 year-old	127	3.20	0.08	3.04, 3.35
22-34 year-old	70	3.42	0.11	3.22, 3.63
35+ year-old	55	3.53	0.12	3.28, 3.77

Care-receiving. Outliers were identified, and the total sample size decreased from 873 to 871.The original prediction had been that the magnitude of expected sex differences in care-receiving would be larger in the Japanese than the Occidental groups (Prediction 10). However the main effect of sex was not significant (Prediction 6) and it was not qualified by any interactions.

It was predicted that the intensity of care-receiving would increase with the progress of relationship stage (Prediction 4) and increase after the birth of child (Prediction 5). There was a significant main effect of relationship stage on care-receiving, $F(3, 846) = 17.98$, $p < .001$, $d = 0.49$ (Figure 2) and the effect was not a linear increase as the relationship became more committed. Table 2 displays means, standard errors, and 95% confidence intervals of scores on the care-receiving scale for each relationship stage. Pairwise comparisons showed that the 'One-sided love' group scored significantly lower than the 'Dating' group ($p < .001$), 'No child' group ($p < .001$), and 'With child' group ($p < .001$). The 'Dating' group also scored significantly lower than the 'No child' group ($p < .05$). Despite the apparent reduction in care-receiving with the arrival of children (Figure 2), there was no significant difference between the 'No child' and 'With child' groups. These finding implied that the level of care-receiving increased with the progress of relationship stage as expected (Prediction 4). However, contrary to Prediction 5, the appearance of child did not increase the degree of care-receiving.

Figure 2

Estimated Marginal Mean Scores of Care-Receiving by Relationship Stage

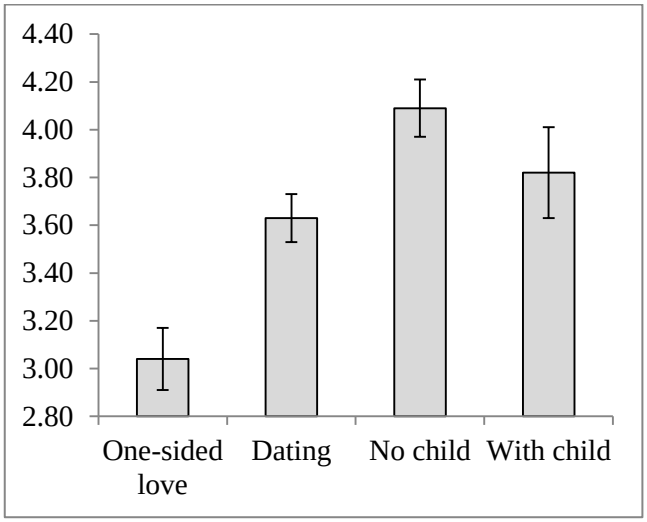


Table 2

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Care-Receiving Scale for Each Relationship Stage Group

Relationship stage	*n*	*M*	*SE*	95% CI
One-sided love	193	3.04	0.07	2.92, 3.17
Dating	373	3.63	0.05	3.54, 3.73
No child	207	4.09	0.06	3.97, 4.21
With child	98	3.82	0.14	3.55, 4.01

There was also a main effect of culture, $F(1, 846) = 47.73$, $p < .001$, $d = 0.46$, in which the Occidental group scored higher than the Japanese group. This was qualified by a significant interaction with age on care-receiving, $F(2, 846) = 4.48$, $p < .01$, $d = 0.19$ (Figure 3). Table 3 displays means, standard errors, and 95% confidence intervals of scores on the care-receiving scale for each age group as a function of culture. A main effect of age was tested for the two cultural groups separately. The main effect of age was significant for both the Japanese and the Occidental groups, $F(2, 385) = 4.11$, $p < .05$, $d = 0.29$, and $F(2, 478) = 6.95$, $p < .001$, $d = 0.34$, respectively. For the Japanese group, pairwise comparisons showed that the youngest ('16-21 year-old') group scored significantly lower than the middle ('22-34 year-old') group ($p < .05$) and the oldest ('35+ year-old') group ($p < .05$). In the Occidental group the oldest ('35+') group scored significantly lower than both the youngest ('16-21') group ($p < .001$) and the middle ('22-34') group ($p < .01$). This finding showed the effect of age on care-receiving had opposite patterns in the two cultural groups, with the youngest group experiencing the lowest care-receiving in the Japanese group, while the oldest group received the lowest level in the Occidental sample. In addition, comparisons between the two cultural groups

showed that the Occidental group scored significantly higher than the Japanese group in all three age categories: the '16-21' group, $F(1, 385) = 93.28$, $p < .001$, $d = 0.98$; the '22-34' group, $F(1, 262) = 25.18$, $p < .001$, $d = 0.61$; and the '35+' group, $F(1, 215) = 4.43$, $p < .05$, $d = 0.28$. This supported Prediction 9, in which Occident participants were expected to score higher on care-receiving than Japanese participants. In addition, the magnitude of this effect was largest in the youngest age group.

Figure 3

Estimated Marginal Mean Scores of Care-Receiving for Each Age Group by Culture

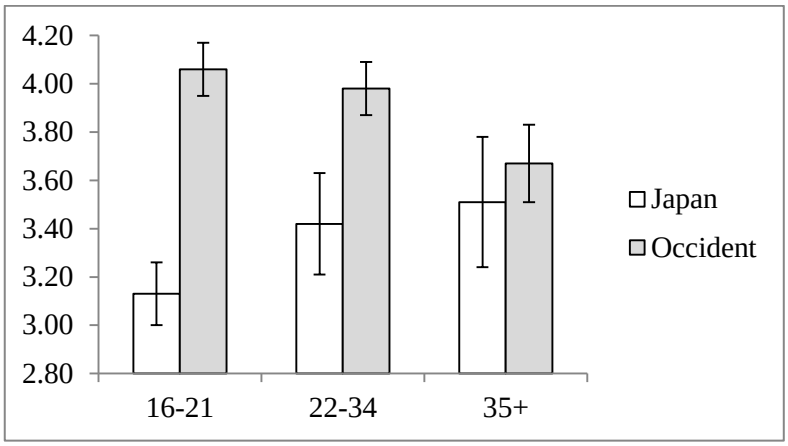


Table 3

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Care-Receiving Scale for Each Age Group by Culture

	Japan			
Age	*n*	*M*	*SE*	95% CI
16-21 year-old	224	3.13	0.07	2.99, 3.26
22-34 year-old	78	3.42	0.11	3.20, 3.63
35+ year-old	87	3.51	0.14	3.24, 3.78
		Occident		
16-21 year-old	164	4.06	0.06	3.94, 4.17
22-34 year-old	187	3.98	0.06	3.86, 4.09
35+ year-old	131	3.67	0.08	3.52, 3.83

Care-giving. Outliers were identified, and the total sample size decreased from 873 to 864. The original prediction had been that the positive relationship between parenthood and care-giving would be stronger for women than men, and the magnitude of expected sex differences in care-giving would be larger in the Japanese than in the Occidental group (see Predictions 8 and 10). However, as with care-receiving, the main effect of sex was not significant (Prediction 6) and it was not qualified by any interactions.

Regarding the main effect of relationship stage on care-giving, it was predicted that the degree of care-giving would increase with the progress of relationship stage (Prediction 4), and increase more after the birth of child (Prediction 5). There was a significant main effect of relationship stage on care-giving, $F(3, 839) = 4.10$, $p < .01$, $d = 0.23$ (Figure 5). Table 4 displays means, standard errors, and 95% confidence intervals of scores on the care-giving scale for each relationship stage. Pairwise comparisons showed that the 'One-sided love' group scored significantly lower than the 'Dating' group ($p < .01$) and the 'No child' group ($p < .01$). There were non-significant differences between the 'Dating', 'No child', and 'With child' groups. This only partially supported Prediction 4. As with the effect of relationship stage on care-receiving, despite the apparent reduction in care-giving with the arrival of children (Figure 4), there was no significant difference between the 'No child' and 'With child' groups. This finding did not support Prediction 5.

Figure 4

Estimated Marginal Mean Scores of Care-Giving by Relationship Stage

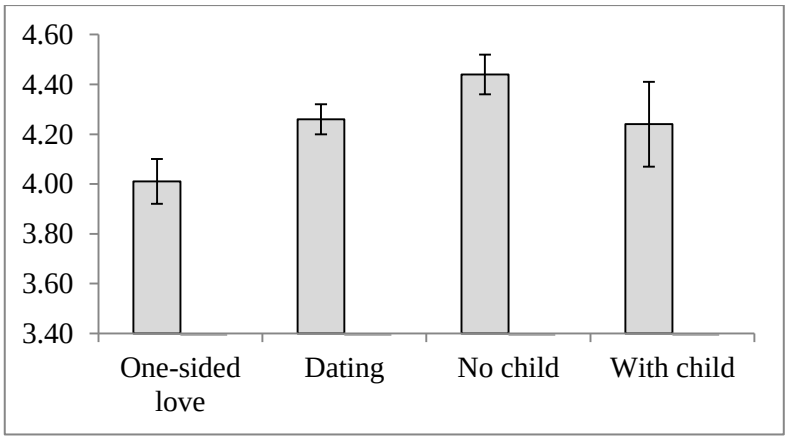


Table 4

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Care-Giving Scale for Each Relationship Stage Group

Relationship stage	*n*	*M*	*SE*	95% CI
One-sided love	191	4.01	0.04	3.92, 4.10
Dating	369	4.26	0.03	4.20, 4.32
No child	207	4.44	0.04	4.36, 4.52
With child	97	4.24	0.09	4.06, 4.41

As with care-receiving, there was a main effect of culture on care-giving, $F(1, 839) = 44.11$, $p < .001$, $d = 0.45$, in which the Occidental group scored higher than the Japanese group. This was qualified by a significant interaction with age, $F(2, 839) = 4.01$,

$p < .05$, $d = 0.19$ (Figure 5). Table 5 displays means, standard errors, and 95% confidence intervals of scores on the care-giving scale for each age group as a function of culture. A main effect of age was tested for the two cultural groups separately. The main effect of age was significant for both the Japanese group, $F(2, 378) = 4.34$, $p < .01$, $d = 0.30$, and the Occidental group, $F(2, 478) = 4.54$, $p < .01$, $d = 0.28$. Pairwise comparisons showed that, for the Japanese group the middle ('22-34 year-old') group scored significantly ($p < .01$) higher than the youngest ('16-21 year-old') group (but not higher than the oldest group), and for the Occidental group the youngest group scored significantly ($p < .01$) higher than the oldest ('35+ ') group (but not higher than the middle group). In addition, comparisons between the Japanese and the Occidental groups showed that the Occidental group scored significantly higher than the Japanese group in all three age categories: the '16-21' group, $F(1, 381) = 66.36$, $p < .001$, $d = 0.83$; the '22-34' group, $F(1, 260) = 7.50$, $p < .01$, $d = 0.34$; and the '35+' group, $F(1, 214) = 23.36$, $p < .001$, $d = 0.66$. This finding supported Prediction 9, in which the Occidental group was expected to show greater care-giving than the Japanese group. As with care-receiving, the magnitude of this cultural effect was largest in the youngest group.

Figure 5

Estimated Marginal Mean Scores of Care-Giving for Each Age Group by Culture

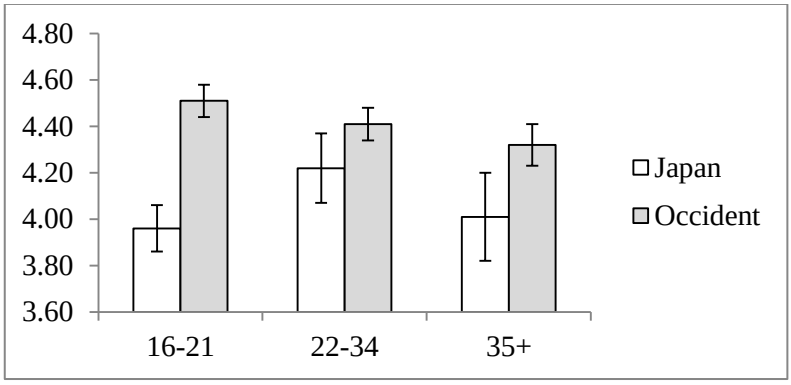


Table 5

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Care-Giving Scale for Each Age Group by Culture

			Japan	
Age	*n*	*M*	*SE*	95% CI
16-21 year-old	220	3.96	0.05	3.87, 4.06
22-34 year-old	76	4.22	0.08	4.07, 4.37
35+ year-old	86	4.01	0.10	3.82, 4.20
			Occident	
16-21 year-old	164	4.51	0.04	4.43, 4.58
22-34 year-old	187	4.41	0.03	4.35, 4.48
35+ year-old	131	4.32	0.05	4.23, 4.41

Separation distress. Outliers were identified, and the total sample size decreased from 873 to 869. The original prediction had been that the positive relations between parenthood and separation distress would be stronger for women than men, and the magnitude of expected sex differences in separation distress would be larger in the Japanese than the Occidental groups (see Predictions 8 and 10). However the main effect of sex was not significant (Prediction 6), and it was not qualified by any interactions.

It was predicted that the degree of separation distress would increase with the progress of relationship stageand after the birth of child (Prediction 4 and Prediction 5). There was a main effect of relationship stage, $F(3, 844) = 3.18$, $p < .05$, $d = 0.20$ (Figure 6). Table 6 displays means, standard errors, and 95% confidence intervals of scores on the separation distress scale for each relationship stage. Pairwise comparisons showed that the 'One-sided love' group scored significantly lower than the 'No child' group ($p < .01$) and the 'With child' group ($p < .05$). Non-significant differences between the 'Dating', 'No child', and 'With child' groups only partially supported Prediction 4. In addition, Figure 6 showed the increase in separation distress after the arrival of children, but non-significant difference between the 'No child' and 'With child' groups did not support Prediction 5.

Figure 6

Estimated Marginal Mean Scores of Separation Distress by Relationship Stage

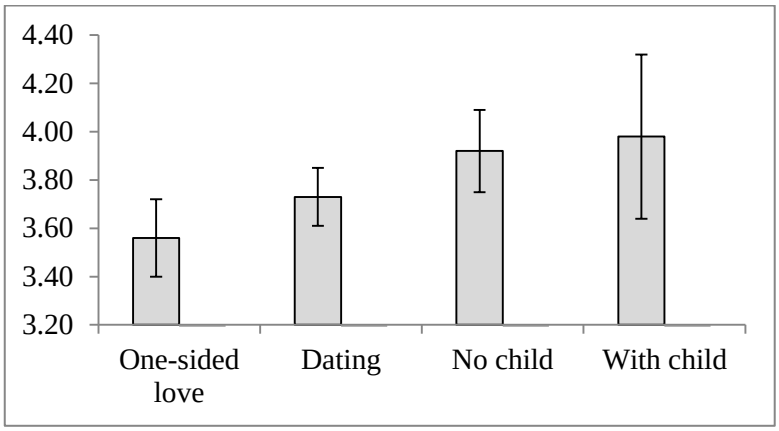


Table 6

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Separation Distress Scale for Each Relationship Stage Group

Relationship stage	*n*	*M*	*SE*	95% CI
One-sided love	192	3.56	0.08	3.39, 3.72
Dating	372	3.73	0.06	3.61, 3.85
No child	207	3.92	0.09	3.75, 4.09
With child	98	3.98	0.18	3.64, 4.32

As expected (Prediction 9), there was also a significant main effect of culture on separation distress, $F(1, 844) = 83.11$, $p < .001$, $d = 0.61$, in which the Occidental group ($n = 480$, $M = 4.15$, $SE = 0.06$, 95% CI [4.04, 4.25]) scored higher than the Japanese group ($n = 389$, $M = 3.41$, $SE = 0.07$, 95% CI [3.28, 3.55]).

Sexual desire for a partner. Outliers were identified, and the total sample size decreased from 873 to 870. The covariate, relationship length, was significantly related to partner-directed sexual desire, $F(1, 845) = 12.31$, $p < .001$, $d = 0.22$. A negative correlation between relationship length and partner-directed sexual desire ($r = -.08$, $p < .05$) indicated that sexual desire decreased with relationship length. There were significant main effects of age, $F(2, 845) = 4.34$, $p < .01$, $d = 0.18$ with the youngest ('16-21 year-old') group scoring lower than the oldest ('35+ year-old') group, sex, $F(1, 845) = 36.99$, $p < .001$, $d = 0.38$, with men scoring significantly higher than women, and culture, $F(1, 845) = 87.21$, $p < .001$, $d = 0.60$, in which Occidentals scored significantly higher than Japanese. These main effects were qualified by significant interactions (see below).

Regarding the effect of age, younger participants were expected to score higher on partner-directed sexual desire than older participants (Prediction 2). There was a significant interaction between age and sex on partner-directed sexual desire, $F(2, 845) =$

9.69, $p < .001$, $d = 0.27$ (Figure 7). Table 7 displays means, standard errors, and 95% confidence intervals of scores on the partner-directed sexual desire scale for each age group as a function of sex. A main effect of age on partner-directed sexual desire was tested for sexes separately. The main effect of age was significant for females, $F(2, 613) = 31.41$, $p < .001$, $d = 0.61$, and pairwise comparisons showed that the youngest ('16-21 year-old') group scored significantly lower than '22-34 year-old' group ($p < .001$) and the oldest ('35+ year-old') group ($p < .001$). This finding (the youngest group scoring the lowest) did not support Prediction 2. The main effect of age was not significant for males, $F(2, 249) = 2.58$, *ns*. In addition, comparisons between sexes showed that men scored significantly higher than women in the youngest ('16-21') group, $F(1, 384) = 16.00$, $p < .001$, $d = 0.40$, and in the oldest ('35+') group, $F(1, 215) = 6.29$, $p < .01$, $d = 0.30$, but not in the middle ('22-34') group, $F(1, 262) = 0.08$, *ns*. This partially supported Prediction 6, in which men were expected to show stronger partner-directed sexual desire than women. These findings showed that men, compared to women, maintained higher partner-directed sexual desire regardless of their age. However, the sex difference was absent between men and women in the middle ('22-34') groups when women's partner-directed sexual desire peaked.

Figure 7

Estimated Marginal Mean Scores of Partner-Directed Sexual Desire for Each Age Group by Sex

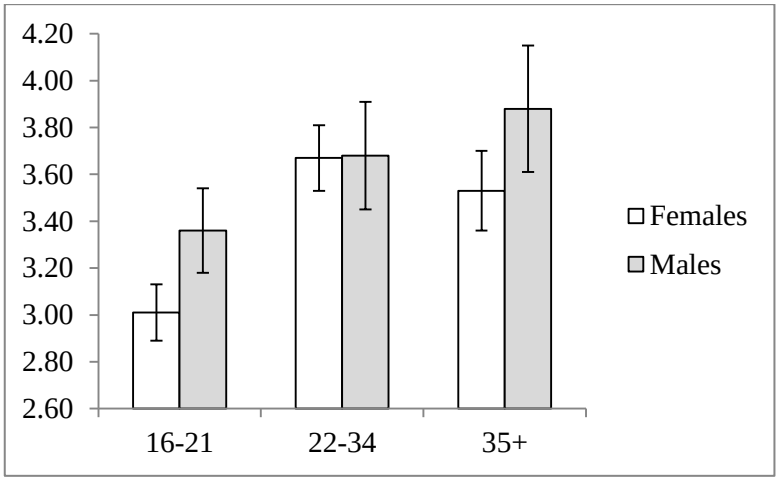


Table 7

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Partner-Directed Sexual Desire Scale for Each Age Group by Sex

	Females			
Age	*n*	*M*	*SE*	95% CI
16-21 year-old	260	3.01	0.06	2.88, 3.13
22-34 year-old	195	3.67	0.07	3.53, 3.81
35+ year-old	162	3.53	0.09	3.35, 3.70
		Males		
16-21 year-old	127	3.36	0.09	3.19, 3.54
22-34 year-old	70	3.68	0.12	3.45, 3.91
35+ year-old	56	3.88	0.14	3.62, 4.15

There was a significant interaction between relationship stage and culture on partner-directed sexual desire, $F(3, 845) = 2.93$, $p < .05$, $d = 0.18$ (Figure 8). Table 8 displays means, standard errors, and 95% confidence intervals of scores on the partner-directed sexual desire scale for each relationship stage as a function of culture. A main effect of relationship stage on partner-directed sexual desire was tested for sexes separately. The main effect of relationship stage was significant for the Japanese group, $F(3, 383) = 9.40$, $p < .001$, $d = 0.54$, and pairwise comparisons showed that the 'One-sided love' group scored significantly lower than the 'Dating' group ($p < .001$) and the 'No child' group ($p < .01$), and the 'With child' group scored significantly lower than the 'Dating' group ($p < .05$) and the 'No child' group ($p < .05$). This finding implies that the level of partner-directed sexual desire appears to follow an inverted U-shaped curve across relationship stages for the Japanese group. The decrease in the level of desire between the 'No child' and 'With child' groups supported Prediction 5, in which parenthood and sexual desire were expected to show a negative association. However, the main effect of relationship stage was not significant for the Occidental group, $F(3, 477) = 2.38$, *ns*. Comparisons between the two cultural group showed that the Occidental group scored significantly higher than the Japanese group in all four groups: the 'One-sided love' group, $F(1, 190) = 91.43$, $p < .001$, $d = 1.39$; the 'Dating' group, $F(1, 370) = 95.68$, $p < .001$, $d = 1.02$; the 'No child' group, $F(1, 204) = 15.15$, $p < .001$, $d = 0.53$; and the 'With child' group, $F(1, 94) = 14.72$, $p < .001$, $d = 0.77$. As expected (Prediction 9), relative to the Japanese group, the Occidental group showed higher levels of partner-directed sexual desire throughout the four relationship stages. In addition, the magnitude of this effect was most marked in the initial stages of relationships.

Figure 8

Estimated Marginal Mean Scores of Partner-Directed Sexual Desire for Each Relationship Stage Group by Culture

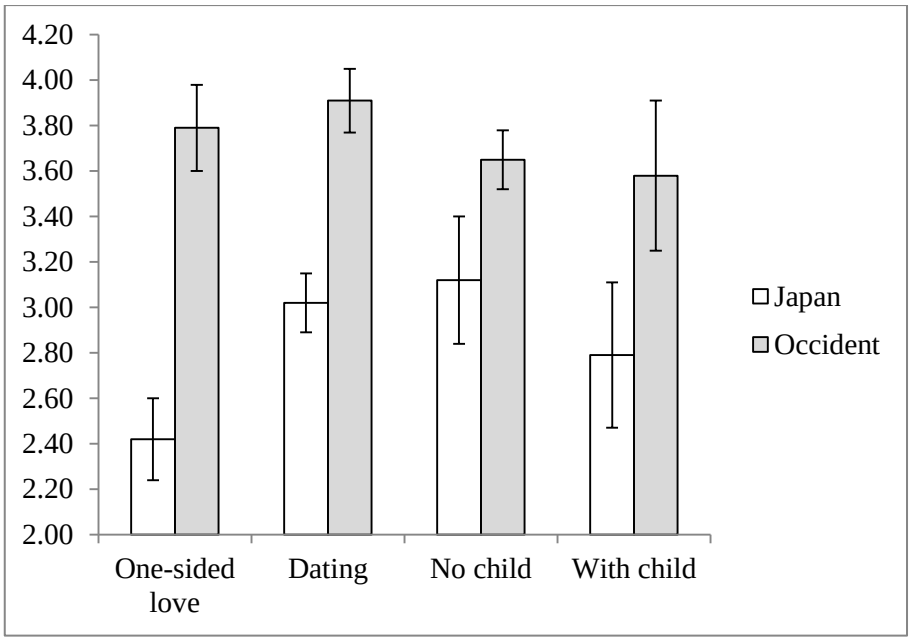


Table 8

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Partner-Directed Sexual Desire Scale for Each Relationship Stage Group by Culture

	Japan			
Relationship stage	*n*	*M*	*SE*	95% CI
One-sided love	101	2.42	0.09	2.25, 2.60
Dating	197	3.02	0.07	2.89, 3.15
No child	38	3.12	0.14	2.84, 3.40
With child	52	2.79	0.16	2.47, 3.11
		Occident		
One-sided love	92	3.79	0.09	3.61, 3.98
Dating	176	3.91	0.07	3.78, 4.05
No child	169	3.65	0.07	3.52, 3.78
With child	45	3.58	0.17	3.26, 3.91

There was a significant interaction between sex and culture on partner-directed sexual desire, $F(1, 845) = 9.16$, $p < .01$, $d = 0.19$ (Figure 9). Table 9 displays means, standard errors, and 95% confidence intervals of scores on the partner-directed sexual desire scale for each cultural group as a function of sex. A main effect of sex on partner-directed sexual desire was tested for the two cultural groups separately. The main effect

of sex was significant for both the Japanese group, $F(1, 385) = 45.85$, $p < .001$, $d = 0.69$, and the Occidental group, $F(1, 479) = 4.19$, $p < .05$, $d = 0.17$, with men scoring significantly higher than women. The magnitude of the effect was greater for the Japanese than the Occidental groups. This finding supported Prediction 10, where the magnitude of the sex difference was expected to be greater in the Japanese than the Occidental group. Furthermore, comparisons between the two cultural groups showed that Occidental men scored significantly higher than Japanese men, $F(1, 250) = 31.46$, $p < .001$, $d = 0.70$, and Occidental women also scored significantly higher than Japanese women, $F(1, 614) = 233.83$, $p < .001$, $d = 1.20$. This supported Prediction 9, in which Occidental participants were expected to show stronger partner-directed desire than Japanese participants. In addition, the magnitude of cultural difference in partner-directed sexual desire was much greater for women than men.

Figure 9

Estimated Marginal Mean Scores of Partner-Directed Sexual Desire for Each Sex by Culture

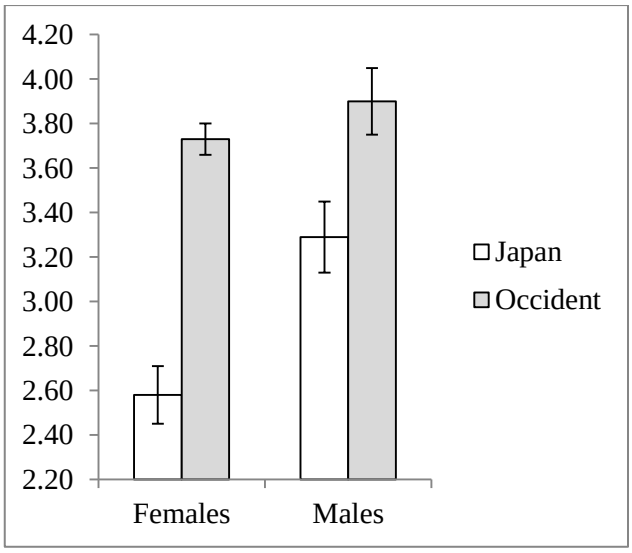


Table 9

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Partner-Directed Sexual Desire Scale for Females and Males by Culture

		Japan		
Culture	*n*	*M*	*SE*	95% CI
Females	243	2.58	0.06	2.46, 2.71
Males	145	3.29	0.08	3.13, 3.45
		Occident		
Females	374	3.73	0.04	3.65, 3.80
Males	108	3.90	0.07	3.75, 4.05

Sexual desire for others. Outliers were identified, and the total sample size decreased from 873 to 871. There were significant main effects of age, $F(2, 846) = 3.00$, $p < .05$, $d = 0.15$, in which pairwise comparisons showed that the youngest scored lower than the oldest, but it was only marginally significant, $p = .06$, sex, $F(1, 846) = 96.64$, $p < .001$, $d = 0.65$, with men scored significantly higher than women, and culture, $F(1, 846) = 14.12$, $p < .001$, $d = 0.24$, with Japanese scored significantly higher than Occidentals. These main effects were qualified by significant interactions (see below).

There was a significant interaction between culture and age on sexual desire for others, $F(2, 846) = 4.27$, $p < .01$, $d = 0.18$ (Figure 10). Table 10 displays means, standard errors, and 95% confidence intervals of scores on the other-directed sexual desire scale for each age group as a function of culture. A main effect of age was tested for the two cultural groups separately. The main effect of age was not significant for either the Japanese, $F(2, 385) = 2.86$, *ns*, or the Occidental groups, $F(2, 478) = 2.34$, *ns*. Comparisons between the two cultural groups showed that the Occidental group scored significantly lower than the Japanese group in the '16-21 year-old' group, $F(1, 385) = 9.69$, $p < .01$, $d = 0.32$, in the '22-34 year-old' group, $F(1, 262) = 5.52$, $p < .05$, $d = 0.29$, and in the '35+ year-old' group, $F(1, 215) = 12.51$, $p < .001$, $d = 0.47$. The significant interaction appears to be attributable to the differential magnitude of the effect, whereby the cross-cultural comparison in the oldest ('35+') group was larger than the two younger ('16-21' and '22-34') groups.

Figure 10

Estimated Marginal Mean Scores of Other-Directed Sexual Desire for Each Age Group by Culture

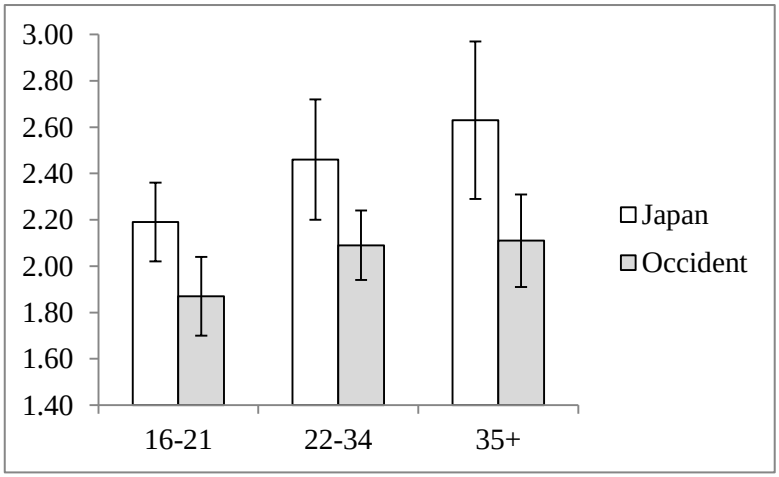


Table 10

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Other-Directed Sexual Desire Scale for Each Age Group by Culture

	Japan			
Age	*n*	*M*	*SE*	95% CI
16-21 year-old	224	2.19	0.09	2.02, 2.36
22-34 year-old	78	2.46	0.13	2.20, 2.72
35+ year-old	87	2.63	0.17	2.30, 2.97
	Occident			
16-21 year-old	164	1.87	0.08	1.71, 2.04
22-34 year-old	187	2.09	0.08	1.94, 2.24
35+ year-old	131	2.11	0.10	1.91, 2.31

There was a significant interaction between culture and relationship stage on other-directed sexual desire, $F(3, 846) = 6.10$, $p < .001$, $d = 0.27$ (Figure 11). Table 11 displays means, standard errors, and 95% confidence intervals of scores on the sexual desire for others scale for each relationship stage as a function of culture. A main effect of relationship stage was tested for the two cultural groups separately. The main effect of relationship stage was significant for the Occidental group, $F(3, 477) = 5.66$, $p < .001$, $d = 0.38$. Pairwise comparisons showed that the 'One sided love' group scored significantly higher than the 'Dating' group ($p < .001$) and the 'No child' group ($p < .01$), and the 'Dating' group scored significantly lower than the 'No child' group. Contrary to Prediction 5 (i.e., there would be a negative association between parenthood and sexual desire), there was no significant difference between the 'No child' and 'With child' groups. The main effect of stage was not significant for the Japanese group, $F(3, 384) = 2.31$, *ns*. Comparisons between the cultural groups showed that the Japanese group scored significantly higher than the Occidental group in the 'Dating' group, $F(1, 370) = 26.68$, $p < .001$, $d = 0.54$, in the 'No child' group, $F(1, 204) = 6.61$, $p < .01$, $d = 0.36$, and in the 'With child' group, $F(1, 95) = 3.94$, $p < .05$, $d = 0.41$. This implies that being in a 'committed' relationships (dating, engaged, cohabiting, married) may reduce the level of other-directed sexual desire in the Occidental group.

Figure 11

Estimated Marginal Mean Scores of Other-Directed Sexual Desire for Each Relationship Stage Group by Culture

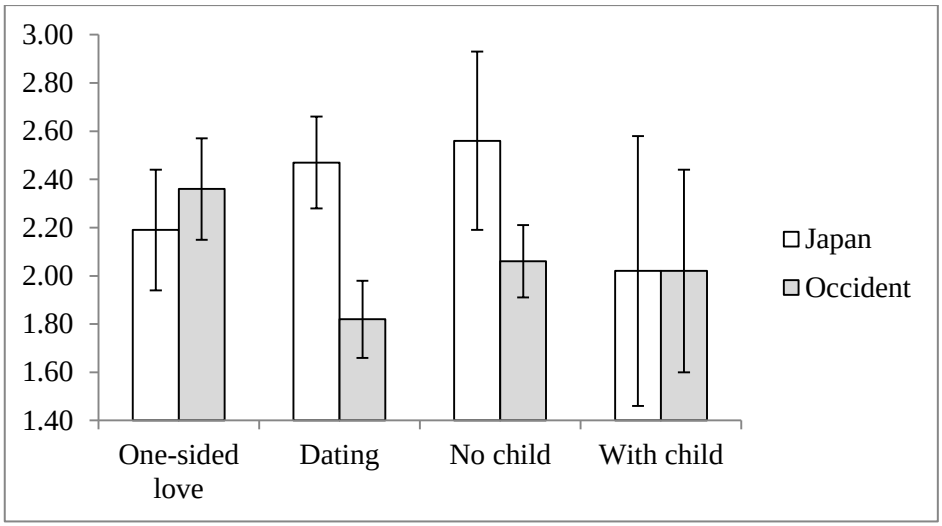


Table 11

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Other-Directed Sexual Desire Scale for Each Relationship Stage Group by Culture

	Japan			
Relationship stage	*n*	*M*	*SE*	95% CI
One-sided love	101	2.19	0.13	1.94, 2.44
Dating	197	2.47	0.09	2.29, 2.66
No child	38	2.56	0.19	2.19, 2.93
With child	53	2.02	0.29	1.45, 2.58
		Occident		
One-sided love	92	2.36	0.11	2.14, 2.57
Dating	176	1.82	0.08	1.66, 1.98
No child	169	2.06	0.08	1.90, 2.21
With child	45	2.02	0.21	1.60, 2.44

It was predicted that men would show stronger other-directed sexual desire than women (Prediction 6), and the magnitude of this sex differences would be greater in the Japanese than the Occidental groups (Prediction 10). As noted earlier, the main effect of sex showed that men scored significantly higher than women. There was also a significant interaction between culture and sex, $F(1, 846) = 8.92$, $p < .01$, $d = 0.19$ (Figure 12). Table 12 displays means, standard errors, and 95% confidence intervals of scores on the sexual desire for others scale for each cultural group as a function of sex. A main

effect of sex on other-directed sexual desire was tested for the two cultural groups separately. The main effect of sex was significant for both the Japanese group, $F(1, 386) = 96.16$, $p < .001$, $d = 1.00$, and the Occidental group, $F(1, 479) = 37.00$, $p < .001$, $d = 0.55$, with men scored higher than women in both cultural groups. In addition, as expected (Prediction 10), the magnitude of the effect was greater in the Japanese than the Occidental group. Comparisons between the cultural groups showed that Japanese men scored significantly higher than Occidental men, $F(1, 250) = 9.46$, $p < .01$, $d = 0.39$, but there was no significant difference between women's sexual desire for others in the two cultures.

Figure 12

Estimated Marginal Mean Scores of Other-Directed Sexual Desire for Each Sex by Culture

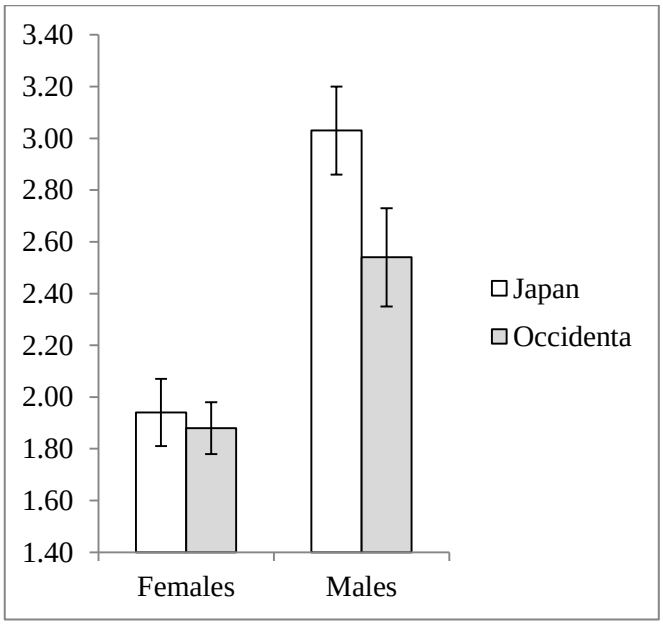


Table 12

Estimated Marginal Means, Standard Errors, and 95% Confidence Intervals (CIs) of Scores on the Other-Directed Sexual Desire Scale for Females and Males by Culture

	Japan			
Culture	*n*	*M*	*SE*	95% CI
Females	243	1.94	0.07	1.80, 2.07
Males	146	3.03	0.09	2.86, 3.20
	Occident			
Females	375	1.88	0.05	1.77, 1.98
Males	107	2.54	0.10	2.35, 2.73

Table 13 presents a summary of the results for all dependent variables.

Table 13

A summary of Results of ANCOVAs: Main and Two-Way Interaction Effects of Age, Relationship Stage, Sex and Culture on the Six Pair-Bond Relationship Dimensions (Obsession, Care-Receiving, Care-Giving, Separation Distress, Sexual Desire for a Partner, and Sexual Desire for Others

	Obsession (N = 870)	Receiving (N = 871)	Giving (N = 864)	Separation (N = 869)	Desire partner (N = 870)	Desire others (N = 871)
				F (d)		
Length	0.01	0.01	1.04	1.46	12.31*** (d = 0.22)	2.09
Age	2.87	0.21	1.49	0.97	4.34** (d = 0.18)	3.00* (d = 0.15)
Stage	2.07	17.98*** **(d = 0.49)**	4.09** (d = 0.23)	3.18* (d = 0.20)	1.02	1.83
Sex	0.01	1.58	0.24	0.72	36.99*** (d = 0.38)	96.64*** (d = 0.65)
Culture	138.43*** (d = 0.79)	47.73*** **(d = 0.46)**	44.11*** (d = 0.45)	83.11*** (d = 0.61)	87.21*** (d = 0.60)	14.12*** (d = 0.24)
Sex×Age	3.73* (d = 0.17)	0.22	0.49	1.63	9.69*** (d = 0.27)	1.21
Sex×Stage	1.34	1.40	2.07	1.63	1.76	2.00
Culture×Age	0.62	4.48* **(d = 0.19)**	4.01* (d = 0.19)	2.87	2.08	4.27** (d = 0.18)
Culture×Stage	2.22	1.07	1.87	2.29	2.93* (d = 0.18)	6.10*** (d = 0.27)
Culture×Sex	0.001	0.16	0.23	0.11	9.16** (d =0.19)	8.92** (d = 0.19)

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

The present study explored whether the six self-reported pair-bond relationship variables differed as a function of temporal factors (age and relationship stage), biological sex, and cultural factors.

The Main Effect of Age

Short-term mating effort: sexual desire for others (Prediction 1). The negative association between age and fertility for both sexes (Balasch, 2010; Dunson et al., 2004; Hassan & Killick, 2003; Kovac et al., 2013; Wallace & Kelsey, 2010) suggests that younger individuals should be expected to allocate more to mating effort than to parental effort. It was predicted that younger individual would show stronger other-directed sexual desire than older individuals (Prediction 1). Indeed, there was a main effect of age on sexual desire for others. However, contrary to the prediction, the youngest ('16-21 year-old') group scored lower than the oldest ('35 + year-old') group.

Pair-bond mating effort: sexual desire for a partner (Prediction 2). Age is negatively associated with fertility (Balasch, 2010; Dunson et al., 2004; Hassan & Killick, 2003; Kovac et al., 2013; Wallace & Kelsey, 2010); thus, it was predicted that younger individuals would score higher on partner-directed sexual desire than older individuals (Prediction 2). There was a main effect of age. However, contrary to the prediction, the youngest ('16-21 year-old') group scored significantly lower than the oldest ('35+ year-old') group. This main effect was qualified by significant interactions with age (see 'The Interaction Effect between Sex and Age').

The Main Effect of Relationship Stage

Short-term mating effort: sexual desire for others (Prediction 3). Individuals at the parental stage may shift their primary life history task from mating to parenting. Thus, it was predicted that there would be negative association between parenthood and the level of other-directed sexual desire (Prediction 3). Contrary to the prediction, the presence of children did not affect the level of other-directed sexual desire. The lack of significant difference between parenthood stage and other relationship stages indicates that parenthood is not associated with the level of interest in extra-pair partners (but see 'The Interaction Effect between Culture and Relationship Stage').

Pair-bond mating effort: sexual desire for a partner (Prediction 5). Parenthood was expected to be negatively associated with the level of partner-directed sexual desire corresponding to the shift of a primary life history task from mating to parenting (Prediction 5). Contrary to the prediction, there was no significant association between parenthood and the level of partner-directed sexual desire. This indicates that

the presence of children did not affect the level of sexual interest in partners (but see 'The Interaction Effect between Culture and Relationship Stage').

Parental effort: **care-receiving, care-giving, and separation distress (Predictions 4 and 5).** It was predicted that the intensity of adult attachment (care-receiving, care-giving, separation distress) would increase with progression through relationship stages (Prediction 4) and after the arrival of children (Prediction 5). The main effect of relationship stage was found in all attachment measures (care-receiving, care-giving, separation distress). Consistent with Prediction 4, the level of care-receiving increased significantly between the 'One-sided love' stage, 'Dating' stage, and 'Engaged, cohabiting, or married with *no* child' stage. The care-giving scores were also lower in the 'One-sided love' than 'Dating' and 'No child' groups. For separation distress, the 'One-sided love' group again scored lower than 'Dating' and 'Engaged, cohabiting, or married *with* child' groups. These findings showed common patterns among care-receiving, care-giving, and separation distress such that the 'One-sided love' group scored the lowest. In support of Prediction 4, the findings suggested that the levels of adult attachment may increase when relationships enter into more serious stages. The lower scores on attachment measures among one-sided love individuals are likely due to the mutual nature of attachment bonds. It was suggested that the development of adult attachment bonds involves mutual commitment (Hazan & Shaver, 1987; Weiss, 1982). In line with this point, the present study showed that attachment bonds were stronger in mutually committed relationships (e.g., dating, engaged, cohabiting, married) compared to one-sided relationships. However, contrary to Prediction 5, there was no significant difference between the 'No child' and 'With child' groups for these three attachment measures (care-receiving, care-giving, separation distress). This may imply that the presence of children did not affect the levels of any of the adult attachment dimensions.

The Main Effect of Sex

Short-term mating effort: sexual desire for others (Prediction 6). The classic sex role perspective predicts that, relative to females, males may allocate more energy to mating effort (Prediction 6). As expected, there was a main effect of sex on sexual desire for others, where men scored significantly higher than women. This main effect was qualified by a significant interaction with culture (see 'The Interaction Effect between Culture and Sex' below).

Pair-bond mating effort: sexual desire for a partner (Prediction 6). Based on the conventional sex role perspective, it was predicted that men would show stronger partner-directed sexual desire than women (Prediction 6). As with sexual desire for others, there was a main effect of sex on sexual desire for a partner, in which men scored significantly higher than women. This main effect was qualified by significant

interactions with age and culture (see 'The Interaction Effect between Sex and Age' and 'The Interaction Effect between Culture and Sex' below).

The Main Effect of Culture

Short-term mating effort: sexual desire for others. There was a main effect of culture on other-directed sexual desire, in which Japanese scored significantly higher than Occidentals. This main effect was qualified by significant interactions with relationship stage and sex (see 'The Interaction Effect between Culture and Relationship Stage' and 'The Interaction Effect between Culture and Sex').

Pair-bond mating effort: sexual desire for a partner (Prediction 9). The high collectivist cultural values imply that one's intimacy is diffused across a larger number of people (Dion & Dion, 1988), and the high masculine cultural values imply that one focuses less on relationships and parenthood (e.g., Simmons, Kolke, &Shimizu, 1986;Van Yperen & Buunk, 1991). These characteristics of individualist-collectivist societies and masculine-feminine societies suggest that Occidentals show stronger partner-directed feelings (including sexual desire) than the Japanese groups (Prediction 9). In line with the prediction, Occidentals showed stronger partner-directed sexual desire than Japanese. This main effect was qualified by significant interactions with relationship stage and sex (see 'The Interaction Effect between Culture and Relationship Stage' and 'The Interaction Effect between Culture and Sex').

Pair-bond mating effort: obsession (Prediction 9). The characteristics of individualist-collectivist societies (i.e., diffused intimacy in collectivist societies) and masculine-feminine societies (i.e., less focused attention on relationships) imply that obsession may be more intense in the Occidental than the Japanese groups (Prediction 9). As expected, there was a large effect of culture on obsession, with the Occidental group scoring higher than the Japanese group.

Parental effort: care-receiving, care-giving, and separation distress (Prediction 9). It has been suggested that, in collectivist societies, tight ingroup interconnectedness within the family dilutes intimacy across a larger number of people, thus resulting in decreased intimacy towards romantic partners (Dion & Dion, 1988). Therefore, it was predicted that the Occidental group would show greater partner-directed attachment than the Japanese group (Prediction 9). There was indeed a significant effect of culture on all three adult attachment measures (care-receiving, care-giving, and separation distress), with the Japanese group scoring significantly lower than the Occidental group in all three. Furthermore, the main effect of culture was qualified by a significant interaction between age on care-receiving and care-giving (although not for separation distress) (see 'The Interaction Effect between Culture and Age').

The Interaction Effect between Sex and Age

Pair-bond mating effort: sexual desire for a partner. It was predicted that younger individuals would score higher on partner-directed sexual desire than older individuals (Prediction 2). There was a main effect of age; however, contrary to Prediction 2, the youngest ('16-21 year-old') group scored significantly lower than the oldest ('35+ year-old') group. Closer examination of the significant interaction between age and sex indicated that the effect of age was only significant for women. For women the youngest ('16-21') group scored significantly lower than the '22-34 year-old' and the oldest ('35+') groups. This may be because that the youngest women, compared to men in the same age range, might have been less comfortable with their sexuality. This is consistent with studies which suggested that the development of psychological sexual maturation might take place at an earlier age for adolescent boys than girls (reviewed in Baumeister et al., 2001). For example, studies showed that boys started having sexual interest, arousal, and fantasies earlier than girls (Asayama, 1975; Knoth, Boyd, & Singer, 1988; Leitenberg & Henning, 1995).

Moreover, the relation between age and fertility may be able to explain why there was the significant main effect of age on partner-directed sexual desire only for women but not for men. Although fertility may decrease with age for both sexes, ageing would not cause the end of fertility for men (Balasch, 2010) while female fertility starts dropping sharply after the late 30s and menopause is reached at the age of about 50 (Eijkemans et al., 2014; te Velde, 2002). This may imply that fertility has more influence on women's than men's partner-directed sexual desire. Since a female reproductive lifespan is shorter than males', women may have evolved to experience stronger partner-directed sexual desire when they are at their most fertile in order to ensure their reproductive success. Women's increased partner-directed sexual desire in the '22-34' group also affected Prediction 6 (men were expected to show the higher level of partner-directed sexual desire than women). Comparisons between the sexes showed that men showed stronger partner-directed desire than women in the youngest ('16-21') and the oldest ('35+') groups in support of the conventional sex role perspective (and Prediction 6). However, the sex difference was absent in the '22-34' year groups, which appears to be due to women's increased sexual desire around this age (for both cultures).

If the present proposal (that the age of women's greatest sexual desire is associated with higher fertility) is correct, it suggests that peak fertility in women should occur between 22 and 34 years of age. This was supported when age at first birth is used as an indicator of female fertility. Cross-cultural data showed that the average age of mothers' first birth was around 28 in 2011, with the majorities of selected countries (except Mexico) were within the age range between around 24 and 30 year-old (OECD, 2014). However, in all countries (in the dataset), first childbirth was more likely to occur

between 20 and 25 years of age in 1970s, and in most countries the average women's age at first birth started to rise in 1970s. These trends in the peak fertility age for women were suggested to be associated with the timing of family formation, which has changed in past few decades (OECD, 2014). This indicates that in addition to a universal peak fertility age, environmental factors (e.g., the timing of family formation) may also be important parameters in determining peak fertility age for women. In line with this point, an alternative explanation for the increased partner-directed sexual desire for women in the '22-34' group is that cultural and social aspects of contemporary lifestyles common to both Japan and Occidental countries might have led this age group to experience stronger sexual desire. That is, women in the '22-34' age group are likely to be at a life stage when they have completed their education, settled into a more stable lifestyle and have begun planning to have a child. This might be reflected in an experience of stronger partner-directed sexual desire. National surveys (conducted in Britain and Japan separately) showed that the average age of mothers at first births was 28.1 in British women and 30.1 for Japanese women (Japan: Ministry of Health, Labour, and Welfare, 2012; United Kingdom: Office for National Statistics, 2012). In both countries, less than 5% of all live births were to mothers aged 20 or less.

Pair-bond mating effort: obsession. Obsession, as a proxy for romantic love, has been functionally connected to the preference for a specific sexual partner and represents the emotional side of partner-directed sexual desire. In line with this perspective, there was a significant interaction between sex and age on obsession, which followed a similar pattern to sexual desire for a partner. As with the effect of age on partner-directed sexual desire, the main effect of age was significant only for women, and women's partner-directed obsession peaked at '22-34 year-old'. For women, the main effect of age on obsession showed that females in '22-34' group scored significantly higher than the youngest ('16-21') group and the oldest ('35+') group. As discussed in the effect of age on partner-directed sexual desire, in terms of the evolved adaptation viewpoint (i.e., females might have evolved to have higher partner-directed sexual desire when they are at their most fertile age), the increased obsession for women in '22-34' group may be corresponding to their higher fertility around this age. In addition, as previously discussed, the effect of modern lifestyles mean that most women in '22-34' age range may be at a life stage when they focus on having children. If the purpose of obsession is to direct and augment attention to a specific individual for successful reproduction (Fisher, 1998), this function may be less relevant to teenagers (who are not ready to become parents) and middle-aged women (who are reaching the end of their reproductive life). However, mixed evidence was also found for this point. While there were positive correlations between obsession and partner-directed sexual desire for the younger females ($r = .56$, $p < .01$ for the '16-21' group and $r = .50$, $p < .01$ for '22-34'

group), the correlation was actually largest for the older ('35+') females ($r = .73$, $p < .01$). If the purpose of obsession is to direct sexual attention to a certain partner for successful reproduction, it is unknown why the link between obsession and partner-directed sexual desire was stronger for the oldest group. This may suggest that the connection between obsession and partner-directed sexual desire might have a different purpose for women around this age. For example, obsession reflects the cost to women of losing a long-term partner, which may increase with age up until menopause.

In addition, women scored significantly higher on obsession than men in the two younger age groups ('16-21' and '22-34' groups). According to the conventional sex role view (e.g., Buss & Schmitt, 1993; Trivers, 1972), men prefer a larger number of sexual partners than women while women have a greater stake in maintaining pair-bonds. These evolved tendencies might have led women to be more obsessive in their thinking about (and more romantically attached to) their partners. Consequently, younger women scored higher on obsession than men, with women's age-dependent fertility decline eliminating the sex difference in obsession for the oldest group. However, previous work has found mixed evidence for sex differences in romantic obsessive thinking. For example, some studies showed that young females are more obsessive than young males (e.g., Butler, Walker, Skowronski, & Shannon, 1995; Hendrick & Hendrick, 1995; Neto, 2007) while others found no such sex difference(e.g., Sprecher & Toro-morn, 2002; Walsh, 1993). Longitudinal research may be able to clarify the effect of age on obsession, especially for women.

The Interaction Effect between Sex and Relationship Stage

Short-term mating effort: sexual desire for others (Prediction 7). Based on the conventional sex role perspective (i.e., relative to females, males may allocate more energy to short-term mating effort than parental effort), it was predicted that a negative association between parenthood and other-directed sexual desire would be weaker for men than women (Prediction 7). However, the level of male (and female) sexual desire for others was not affected by the presence of children. The lack of significant difference between parenthood stage and other relationship stages indicates that parenthood is not associated with the level of men' (and women') s interest in extra-pair partners. Indeed, recent theoretical developments have begun to recognize that sex roles may not be clearly distinctive as the classic models suggested and that other factors such as reproductive environments, sex-specific breeding costs, mortality cost, and mate qualities (Gangestad & Simpson, 2000; Kokko & Monaghan, 2001) may also contribute to variability in human mating patterns.

Parental effort: care-receiving, care-giving, and separation distress (Prediction 8). Based on the conventional sex role perspective (i.e., relative to males, females allocate more to parental than mating efforts), the magnitude of the positive associations between parenthood and care-giving/separation distress were expected to be stronger for women than men (Prediction 8). Contrary to the prediction, the level of attachment for women (and men) was not affected by the presence of children. This implies that parenthood does not influence the intensity of attachment feelings towards partners.

The Interaction Effect between Culture and Age

Parental effort: care-receiving, care-giving, and separation distress. There was a significant effect of culture on care-receiving, care-giving, and separation distress, with the Japanese group scoring significantly lower than the Occidental group in all three. This main effect of culture was qualified by a significant interaction between age on care-receiving and care-giving (although not for separation distress). For the Japanese group, the effects of age on care-receiving and care-giving followed a similar pattern. For care-receiving the youngest ('16-21 year-old') group scored lower than the two older age groups ('22-34 year-old' and '35+ year-old'), and for care giving the youngest group again scored lower than the slightly older ('22-34') group (although there was no significant difference between the youngest and the oldest groups). This was in contrast to the results for Occidental participants. For care-receiving, it was the oldest age group ('35+') that scored lower than the two younger groups ('16-21' and '22-34'), and for care-giving the oldest group again scored lower than the youngest group. These findings indicate that the youngest group showed the lowest mutual attachment (care-receiving and care-giving) in the Japanese group, while the oldest group tended to show the lowest levels in the Occidental group.

One explanation for this finding is that the degree of connectedness with natal family members might have enhanced the magnitude of cultural difference between the young participants from the two cultural groups. It was proposed that after the formation of initial infants-parents attachment bonds, individuals continue to form attachment bonds with multiple figures (Antonucci, Akiyama, & Takahashi, 2004; Hazan & Zeifman, 1994; Trinke & Bartholomew, 1997). These attachment figures constitute an attachment hierarchy, in which a primary attachment figure may change over the course of the lifespan. One of the characteristics of individuals in young adulthood might be that they are in the midst of transferring attachment from parents to peers and romantic partners (Hazan & Zeifman, 1994). It was suggested that, in the West, adolescence is a time when individuals are likely to leave home and form close relationships with peers, while this transfer might be delayed in collectivist societies due to the tight connectedness to family

members (You & Malley-Morrison, 2000). For instance, statistics show that the proportion of undergraduate students living at home was more than double in Japan (50%) compared to the 19% in the United Kingdom (National Federation of University Co-operative Associations, 2014; Higher Education Statistics Agency, 2012). This might imply that the transition of attachment from parents to romantic partners may be delayed in the youngest individuals in the Japanese group because they remain closer to family members. The strong connectedness with family members for the young Japanese might have decreased the levels of care-receiving and care-giving relative towards romantic partners, thus reflecting in lower levels of attachment for the young Japanese than the young Occidentals. In line with this point, comparison between the two cultural groups also showed that although the Occidental group scored higher than the Japanese group on care-giving and care-receiving in every age category, the magnitude of cultural difference was largest between the youngest groups. However, it is unknown why the oldest group tending to show the lowest levels of care-receiving and care-giving in the Occidental group. Longitudinal research with considering environmental factors (e.g., education histories, relationship with family members) may be able to clarify the effect of age on attachment components.

Although the main effect of culture on care-receiving and care-giving were qualified by age, there was no such significant interaction effect for separation distress. This implies that the level of separation distress did not vary among different age groups for either the Japanese or Occidentals. These findings may represent the difference between the nature of care (receiving and giving) and separation distress. That is, care-receiving and care-giving may involve active behaviour towards attachment figures, whereas separation distress might be a passive emotional reaction to separation from attachment figures. In the previous factor analytic study (Chapter Three), there was a positive and moderate association between care-receiving and care-giving. This suggests that individuals are required to show constant mutual commitment (care-receiving and -giving) in order to maintain attachment bonds. These acts, indicative of mutual commitment, may be more frequent with physically closer individuals (e.g., who they live with, meet every day). This might have been reflected in the lower levels of care-receiving and care-giving between partners for the young Japanese who were expected to spend more time with their natal family members around this age. On the other hand, separation distress may function as the activation of attachment behaviours in response to stressful conditions (Fraley & Shaver, 1998). Thus, it might be context- and event-dependent (e.g., fearful of future or permanent separation), which individuals may not experience regularly. Therefore, the degree of connectedness towards family members (or other individuals) might have not affected the level of separation distress from romantic partners that much. However, one might also expect that the Japanese youth

should experience greater separation distress towards partners if they spend more time with family and less time with partners. Future study may test the associations between the degree of connectedness with primary attachment figures, and how it affects the levels of mutual commitment and separation distress towards other attachment figures.

The Interaction Effect between Culture and Relationship Stage

Short-term mating effort: sexual desire for others. There was a significant interaction between relationship stage and culture. The main effect of relationship stage was only significant for the Occidental group. The significant main effect within the Occidental group showed that the strength of other-directed desire was highest in the 'One-sided love' group, followed by the 'Engaged, cohabiting, married individuals with *no* child' and the 'Dating' group. For the Occidental group, the higher other-directed sexual attraction among 'One-sided love' individuals (relative to 'Dating' and 'No child' individuals) may indicate that mutually committed relationships may make the pair-bond relationships more exclusive. However, non-significant differences between 'One-sided love' and 'Engaged, cohabiting, married individuals *with* child', and between 'No child' and 'With child' groups also imply that mutual commitment may not be the main factor which leads individuals to form more exclusive sexual relationships. These rather mixed findings might have been due to a wider confidence interval of scores on other-directed sexual desire for 'With child' groups compared to other relationship stage groups (see Table 11). This may suggest that data are required from a larger number of individuals with children in order to confirm whether mutual commitment affects the strength of other-directed sexual desire for the Occidentals. More interestingly, the main effect of relationship stage was not significant for the Japanese group, which implies that being in mutually committed relationships does not affect the level of sexual attraction towards extra-partners for the Japanese group. These findings suggest a cultural difference in how individuals perceive the link between sexual behaviours and pair-bond relationships. According to the cultural dimension theory, a key difference between masculine and feminine societies in a pair-bond relationship context is that sexual behaviours are experienced as "a way of performing" in masculine societies (i.e., Japan) whereas they are experienced as "a way of relating" in feminine societies (i.e., Occidental countries) (Hofstede, 2001, p.328). This is confirmed by a study which showed that a positive association between sexual behaviours and romantic feelings was stronger in a feminine society than in a masculine society (Foa et al., 1987). Indeed, the previous factor analytic study (Chapter Three) showed the negative associations between attachment dimensions and other-directed sexual desire in the Occidental group but not in the Japanese group. This was reflected in comparisons between the cultural groups which showed that the Occidental group scored lower than the Japanese group, except at the one-sided love

stage. Informed by the cultural dimension theory and previous studies, the finding in the present study suggests that a connection between sexual attraction and romantic feelings toward a partner may be stronger in Occidental countries than in Japan. As a result, Occidental participants might have showed lower levels of other-directed sexual desire than Japanese participants, while relationship stage did not affect levels of other-directed sexual desire in Japanese participants.

Pair-bond mating effort: sexual desire for a partner. As with other-directed sexual desire, there was a significant interaction between relationship stage and culture. In line with Prediction 9, Japanese participants scored significantly lower on partner-directed sexual desire than the Occidental group in all relationship stages. Moreover, this time, a main effect of relationship stage was significant only for the Japanese group. The level of partner-directed sexual desire appeared to follow an inverted U-shaped curve across relationship stages. The significant decrease in the intensity of partner-directed sexual desire between the 'Engaged, cohabiting, married individuals with *no* child' and 'Engaged, cohabiting, married individuals *with* child' groups suggests that the arrival of children might have decreased sexual attraction towards partners in the Japanese group. This supported Prediction 4, in which parenthood was expected to be negatively associated with the level of sexual desire corresponding to the shift of a primary life history task from mating to parenting. However, this finding (and the main effect of relationship stage) was only true for the Japanese group but not for the Occidental group. Therefore, the negative association between parenthood and partner-directed sexual desire might have been induced by cultural factors. One explanation for this finding could be that the birth of children birth may change individuals' self-concept more dramatically in collectivist societies where one's sense of self is inseparable from the immediate social context and is strongly connected with one's role in a social and family unit (Markus & Kitayama, 1991). Kinship terminology in Japan confirms this point. In the Japanese language, personal pronouns are often determined by social role (Suzuki, 1973). Within a familial context, individuals are often labelled in terms of kin relationships in which a youngest child as a reference point (Liu, 2001; Suzuki, 1973). For example, if a married couple have a baby, they will start calling each other 'mother' or 'father' instead of using their first names or 'you' as in English. Japanese may (consciously or unconsciously) shift their perception of their partners from romantic partners to a parent-based identity based on roles within familial context. Consequently, Japanese participants, compared to Occidental participants, might have viewed their relationship as less 'sexual' after having children.

The Interaction Effect between Culture and Sex

Short-term mating effort: sexual desire for others (Prediction 10). It was predicted that sex differences would be greater in more masculine than more feminine societies (Prediction 10). This prediction was supported. There was a significant interaction between culture and sex, in which males scored higher than females in both cultural groups. As expected, the magnitude of the effect was greater in the Japanese than the Occidental groups. Furthermore, within-sex comparisons showed that Japanese men scored higher than Occidental men, although there was no significant difference between Japanese and Occidental women. The greater sex differences in the Japanese group arise from Japanese men's higher other-directed sexual desire relative to Japanese women's. According to Hofstede (1998), gender roles are more distinct in masculine societies so that men are expected to be more 'masculine' (e.g., assertive) and women to be more 'feminine' (e.g., modest). On the other hand, gender roles are less distinct in feminine societies, and both men and women are expected to be more 'feminine'. This implies that men's tendency to focus more on short-term mating effort than women (Buss & Schmitt, 1993; Darwin, 1871; Trivers, 1972) might be culturally enhanced in masculine societies, thus making sex differences greater in the Japanese group than in the Occidental group. The findings in the present study suggested that culture is an important factor affecting sexual motivations in short-term relationships.

Pair-bond mating effort: sexual desire for a partner (Prediction 10). As with other-directed sexual desire, there was a significant interaction between sex and culture on partner-directed sexual desire. In line with the conventional sex role perspective (Prediction 6), men showed stronger partner-directed desire than women across both cultural groups. Moreover, as expected, the magnitude of this sex difference was again larger in the Japanese group than in the Occidental group (Prediction 10). In line with Prediction 9, both Occidental men and women showed stronger partner-directed sexual desire than Japanese men and women, but cultural differences were greater for women than men. This finding is consistent with the cultural dimension theory, in which women are expected to be less sexually active in more masculine societies (Hofstede, 1998). Indeed, a recent study showed that Occidental women (e.g., North American, European) reported stronger sexual desire than East Asian women (e.g., Japanese, Chinese), with a negative association between sex guilt and sexual desire among East Asians (Woo, Brotto, & Gorzalka, 2011).

Limitations and Conclusion

There are several limitations to the conclusions that can be reached from the present study. First, the study was based on cross-sectional data. Hence, the effects of birth cohort and aging could not be separated. Cultural norms and values are expected to

change over time; thus, it is possible that differences among age groups represent generation gaps. Second, age and relationship stage are not unconnected and further work is needed to establish the unique effects of these two variables. Third, although cultural differences were interpreted using the cultural dimension of individualism-collectivism and masculinity-femininity, these were not directly assessed in the samples used in the present study. Therefore, it is possible that cultural differences found in the present study were influenced by other unknown cultural (or non-cultural, such as economic) factors.

The present study showed that temporal factors (age and relationship stage), biological sex, and cultural differences affected the six pair-bond relationship dimensions. *Age* influenced the intensity of most of the relationship dimensions. In pair-bond mating effort (obsession and partner-directed sexual desire), the main effect of age was significant only for females, in which their partner-directed obsession and sexual desire peaked at the '22-34 year-old' group. There are two possible explanations for this finding. First, the higher levels of partner-directed mating effort (obsession and sexual desire) around this age ('22-34') may indicate that females might be most fertile at this period. A second explanation is that modern lifestyles might have motivated women in this age to experience higher obsession and partner-directed sexual desire. In both Japan and Occidental countries, women in '22-34' age group are likely to be at the life stage when they have begun planning to have a child. In either case, the findings implied that women's levels of mating effort may be more vulnerable to other factors (e.g., fertility, environmental context) than males. In parental effort (care-receiving and care-giving), age interacted with culture, such that mutual attachment levels were lowest among youngest individuals in the Japanese group whereas they were lowest among the oldest individuals for the Occidental group. It was suggested that young Japanese individuals, compared to the young Occidentals, may be more closely attached to their natal family group, resulting in lower attachment towards their romantic partners. However, the effect of age was not qualified by culture for separation distress. The different patterns found for mutual commitment (care-receiving and care-giving) and separation distress implies that there may be qualitative differences between them.

Relationship stage influenced the intensity of most relationship dimensions as either a main effect (on attachment components) or in interaction with culture (partner- and other-directed sexual desire). Regarding parental effort (care-receiving, care-giving, and separation distress), there was a main effect of relationship stage: As expected, the levels of care-receiving, care-giving, and separation distress were higher in mutually committed relationships (e.g., dating, engaged, cohabiting, married) than one-sided relationships. However, the presence of children did not affect the levels of any of the attachment components. Regarding short-term mating effort (other-directed sexual

desire), there was an interaction between stage and culture. For the Occidental group, where the level of other-directed sexual desire was highest at the one-sided love stage, mutual commitment may play an important role for the formation of exclusive pair-bond relationships. Regarding pair-bond mating effort (partner-directed sexual desire), the effect of relationship stage was again qualified by an interaction with culture. For the Japanese group, the level of partner-directed sexual desire increased with the progress of relationship stage, but decreased after the arrival of children. In Japan, the appearance of children may change partners' roles in the family unit, resulting in a shift in perception of partners from 'romantic' to 'parental'.

Sex affected the intensity of both short-term (other-directed sexual desire) and pair-bond mating effort (obsession and partner-directed sexual desire). Consistent with the conventional sex role view, men showed stronger other-directed and partner-directed sexual desire. However, for partner-directed sexual desire, this sex difference was absent between men and women in the '22-34 year-old' groups. As discussed, this may be due to sexual desire among women rising to meet that of men during their most fertile life stage or during the life stage when they plant to have a child. In addition, the few sex differences found in romantic love (i.e., obsession) and attachment bonds were consistent with suggestions that males and females are more alike than different in most psychological traits (Hyde, 2005; Stewart-Williams, 2013). Although the level of obsession for females was affected by age, these results broadly indicated that romantic love and attachment mechanisms operate with similar strength in men and women. This may supported the hypothesis which suggested humans have evolved to be bi-parental animals (e.g., Eastwick, 2009; Fisher, 1989; Lovejoy, 1981).

Lastly, *culture* influenced the intensity of every relationship dimension. In addition to main effects on all six dependent variables, it showed the largest number of interactions. In line with the cultural dimension theory, the Occidental group (as the more individualistic and feminine societies) showed greater partner-directed obsession and attachment (care-receiving, care-giving, and separation distress) than the Japanese group. Regarding the individualism-collectivism dimension, Japanese people may be integrated into a larger social group (especially the extended family) with attachment divided between them, resulting in lessened intimacy towards a romantic partner. By contrast, Occidental individuals appear to be more focused on their relationship to their romantic partner. Moreover, consistent with the masculine characteristics of Japan, the magnitude of sex differences for both other- and partner-directed sexual desire was larger in the Japanese than the Occidental group. This suggests that the conventional sex role view (males allocate more to mating effort than females) may be influenced by cultural factors.

Chapter Five
The Effects of Sex and Personality

Introduction

Using a large British sample, the present study examined associations between self-reported relationship variables (sexual desire, romantic love and adult attachment) and personality traits (General Factor of Personality and Dark Triad), and whether these associations differed as a function of respondents' sex in ways predicted by life history theory.

Differential K Theory

Life history theory proposes that since available resources (e.g., energy) and the life span of each organism are finite, allocation of resources to each life history task often involves trade-offs, including *mating* effort and *parental* effort. Decisions (either conscious or unconscious) need to be made about these trade-offs in order to maximize fitness in specific circumstances. From a broad life history strategy perspective, *r*/*K* selection theory was proposed by MacArthur (1962; MacArthur & Wilson, 1967) and Wilson (1975) and extended by Pianka (1970). It invokes ecological factors, such as the stability and carrying capacity of the environment, as the key variables that determine the intrinsic rate of species-typical life history tempo. According to the theory, *r*-selected species have 'fast' life strategies characterized by a shorter lifespan and a tendency to allocate energy to producing large numbers of offspring. By contrast, *K*-selected species have 'slow' life strategies characterized by a longer lifespan and a tendency to produce fewer and more costly offspring at the expense of increased parental investment. Based on the *r*/*K* theory's criteria, the great apes, including humans, are *relatively* at the *K* (or slow) end of the continuum (Lovejoy, 1981; Rushton, 1985) compared to other species such as frogs or rabbits. However, the recent theoretical and empirical development have suggested that other factors such as mortality patterns appear to be more pertinent to predicting life history strategies (Reznick, Bryant, & Bashey, 2002). In addition, some species show components of both fast and slow life history strategies (Kraus, Thomson, Künkele, & Trillmich, 2005), implying that a single fast-slow continuum does not explain all the variance across species in life history strategies.

Although the original *r*/*K* theory was developed to explain between-species differences, Rushton (1985) applied the theory to *within*-species variation and proposed differential K theory in order to explain individual differences in humans. He accepted that humans (as a species) are K-selected strategist in comparison to other species, but argued that individuals differ in their level of '*K*'. According to him, a single life-historycontinuum (Differential K) with a negative and positive pole can be used to

describe individual differences in life history strategies. These individual differences are argued to have a strong genetic component (Rushton, 1985). Compared to individuals at the 'fast' (low K) end of the spectrum, 'slower' (high K) individuals are predicted to allocate relatively more time and energy to survival than reproduction (e.g., greater body size and longevity, and lower maturation rate and sex drive; Rushton, 1985) and to parental effort rather than mating effort (e.g., selective mating, formation of long and committed relationships, and greater parental investment; Figueredo et al., 2006; Lovejoy, 1981). In line with differential K theory, subsequent factor analytic studies on self-reported life history variables identified a single common factor (e.g., Figueredo, Vásquez, et al., 2005; Figueredo et al., 2007). This single factor was positively defined by loadings from life history parameters related to survival and intensive parental effort (e.g., health, relationship quality with others) while negatively defined by loadings from life history parameters related to anti-social behaviours and mating effort.

It should be noted that differential K theory has diverged greatly from the original *r*/*K* theory. Although there have been theoretical development in relation to the original *r*/*K* theory, they have not been reflected in differential K theory. Thus, the nature of the term 'K' used in differential K theory is not equivalent to *'K*' in the original *r*/*K* theory. In differential K theory, 'K' represents the constellation of many aspects of life history aspects (e.g., health, relationship quality with peers, families, and romantic partners, and social behaviours) as a single life history continuum with 'high K' or 'slow life history tempo' at one extreme and 'low K' or 'fast life history tempo' at the other (Figueredo et al., 2004; Rushton, 1985). The focus of this study was not the appropriateness of applying a theory developed for between-species differences to within-species differences, but rather to test hypotheses and predictions generated from differential K theory in relation to the dimensions of pair-bond relationships.

In the present study, four dimensions of pair-bond relationships were examined: romantic love, adult attachment, sexual desire for a partner, and sexual desire for others. Conceptually integrating the dimensions of heterosexual relationships into a classic single life history continuum, adult attachment were expected to be associated with parental effort, sexual desire for a partner and romantic love with pair-bond mating effort, and sexual desire for others with short-term mating effort (see also Chapter Four). Pair-bond mating effort and parental effort were expected to be associated with a relatively 'slower' life history trajectory. Indeed, a previous factor analytic study (Figueredo, Vásquez, et al., 2005) showed that romantic attachment (security and emotional closeness) loaded positively on 'K-factor', with its positive pole indicating a slower life history tempo. Regarding mating effort in a short-term context (other-directed sexual desire), it may be associated with a relatively faster life history tempo.

General Factor of Personality

Personality traits are observable as "an individual's set of typical behavioural tendencies" (Penke, Denissen, & Miller, 2007, p. 550) and it has been suggested that different personality traits are associated with different reproductive strategies (Nettle, 2006). Rushton, Bons, and Hur (2008) argued that many personality traits can be subsumed under a single higher-order trait and that this trait is associated with individual differences in life history strategy. The existence of this higher-order personality factor, called General Factor of Personality (GFP), was established using a range of different personality inventories (Musek, 2007). In one such study, based on research by Musek (2007), GFP was derived from the Big Five personality constellation (Costa & McCrae, 1992a; Digman, 1990). The five dimensions, all of which loaded positively on GFP, are *Extraversion* (e.g., excitement seeking), *Agreeableness* (e.g., compliance), *Conscientiousness* (e.g., self-discipline), *Emotional Stability* (e.g., absence of anxiety), and *Openness* (e.g., aesthetics). Rushton et al. (2008) asserted that GFP is analogous to the single life history dimension, in which the high end of GFP corresponds to the slow end of the life history continuum. His assertion was that life history strategic 'decisions' are mediated by this suite of personality traits that form the temperamental infrastructure supporting more stable partner bonds, more intense parental investment, and greater lifestyle stability. Correlational studies have shown positive associations between GFP and slow life history parameters (e.g., high-K strategy, age at death, future time perspective; Dunkel & Decker, 2010; K-factor, covitality; Figueredo et al., 2007; parental effort; van der Linden, Figueredo, de Leeuw, Scholte, & Engels, 2012).

In the present study, I examined the extent to which GFP is associated with dimensions of heterosexual relationships. If GFP is positively associated with selective and stable pair-bonds and parental investment, individuals with higher GFP were expected to show greater mating effort in a pair-bond context (indexed as higher on romantic love and sexual desire for a partner), greater parenting effort (indexed as higher on attachment), and lower mating effort in a short-term context (indexed as lower on sexual desire for others).

The Dark Triad

Psychologists have recently identified another personality dimension that may be associated with mating strategy; the 'Dark Triad' (Paulhus & Williams, 2002). This is a constellation of the three personality traits of *Machiavellianism*, *Psychopathy*, and *Narcissism* (Paulhus & Williams, 2002). Machiavellians are described as interpersonally cold, manipulative, and exploitative. Psychopaths are characterized as impulsive, thrill-seeking, and are low in empathy and anxiety. Narcissists tend to be grandiose, with a strong sense of entitlement and superiority (reviewed in Jonason, Li, Webster, & Schmitt,

2009). Jonason and Webster (2010) conducted factor analyses on self-reported data and showed correlated latent constructs of Machiavellianism, psychopathy, and narcissism, which they used to develop their brief measure ('the Dirty Dozen') of Dark Triad (DT).

Although DT seems to be a constellation of socially undesirable traits, some have suggested that individuals with high DT may be more successful in mating by adopting an exploitative short-term mating strategy (e.g., Jonason, Koenig, & Tost, 2010). Indeed, individuals who scored higher on the DT scale were more open to casual sex and had more sex partners (Jonason et al., 2009). There was also a consistent negative correlation between DT and romantic experiences across different cultural groups (Jonason, Li, & Czarna, 2013), indicating that high DT individuals may have a propensity to form uncommitted romantic relationships. Furthermore, it was suggested that, in direct contrast to GFP, DT-related personality traits are an inverse indicator of 'slow' life history (e.g., Jonason, Koenig, & Tost, 2010). For instance, antisocial personality traits and the constellation of slow life history parameters showed significant negative correlations (e.g., between 'Mini-K', 'High-K strategy', and 'future time perspective', and 'sociosexuality'; Dunkel & Decker, 2010; 'Mini-K' and 'psychopathy'; Jonason et al., 2010). Factor analytic studies also showed that Machiavellianism and psychopathy loaded negatively on a single life history factor (Figueredo et al., 2005; Gladden, Sisco, & Figueredo, 2008).

If DT is an inverse indicator of 'slow' life history (e.g., Jonason, Koenig, & Tost, 2010), a negative correlation was predicted between DT and GFP. In contrast to GFP, DT was expected to be negatively related to parental effort (adult attachment) and pair-bond mating effort (romantic love and sexual desire for a partner), and positively associated with short-term mating effort (sexual desire for others).

Sex Differences

The above proposals must be qualified by a consideration of sex differences. Classic models predict that females to be more 'choosy' and males to be more competitive (Bateman, 1948; Darwin, 1871; Trivers, 1972). However, the recent theoretical developments have begun to recognize that sex roles may be more flexible and less divergent than the classic models argue (Kokko & Jennions, 2008, see also Chapter One). Current debate regarding the conventional sex roles and their correlates made predictions about sex differences in the present study difficult. In this thesis, I tested sex differences in psychological mechanisms underlying pair-bond relationships (i.e., sexual desire, romantic love, and adult attachment) from the broad conventional sex role perspective, and explored to what extent sex differences were evident. The conventional sex role argument predicts that men, compared to women, invest more in short term mating effort. This has been supported by data showing men's higher sex drive and a

tendency to prefer a larger number of sexual partners than women (Baumeister, Catanese, & Vohs, 2001). Men's higher sex drive further predicts that both types of sexual desire (partner- and other-directed) are higher in men than women. On the other hand, the conventional sex role argument predicts that women, compared to men, invest more in parental (attachment) effort due to their heavier obligate parental investment and reproductive cost (Buss & Schmitt, 1993). Based on this and on previous research on sex differences in sexual desire (Baumeister et al., 2001), it was predicted that sexual desire for a partner and others (a physical aspect of mating effort) would be higher in men than women, while adult attachment (parental effort) would be higher in women than men.

With regard to the broad personality traits (GFP and DT), although Rushton et al. (2008) described GFP as an indicator of relative position on the single life history continuum, scant attention was paid to the possibility of sex differences (Muncer, 2011). In line with the conventional sex role argument, a study by Figueredo et al. (2005) showed that women scored higher on a constellation of slower life history parameters (high investment) than men. Consequently GFP, as a positive indicator of slower life history (Rushton et al., 2008), was predicted to be greater in women than men. In addition, if DT is an indicator of faster life history strategy (e.g., Jonason et al., 2010), men were expected to score higher on DT than women. Indeed, previous work showed that men scored significantly higher on the DT scales than women, and DT was positively associated with short-term mating strategies (Jonason et al., 2009; Jonason & Webster, 2010).

The Current Study

In the present study, four self-report measures were used to assess romantic love, adult attachment, sexual desire for a partner, and sexual desire for others. Existing scales were used to measure GFP and DT (the Dirty Dozen scale; Jonason & Webster, 2010; the Big Five Inventory-10; Rammstedt & John, 2007). Informed by a life history framework, I analysed how respondents' personality traits and sex affected allocation decisions about mating and parental efforts. Below is the summary of predictions.

If GFP and DT are indicators of the slower and faster life history continuum respectively, predictions are as follows.

1. GFP and DT will be negatively correlated.
2. GFP will positively predict and be correlated with partner-directed romantic love, adult attachment, and sexual desire. DT will negatively predict and be correlated with these variables.
3. GFP will negatively predict and be correlated with sexual desire for others. DT will positively predict and be correlated with this variable.

I also tested sex differences in relationship and personality traits measures from the conventional sex role perspective.

4. Compared to women, men will have higher scores on sexual desire (for a partner and others) and on DT. Women will have higher scores on adult attachment and GFP.

I examined whether sex moderates the associations between relationship and personality traits measures as assumed by the conventional sex role explanations.

5. The positive associations between GFP and adult attachment will be stronger in women, while the negative associations between DT and adult attachment will be stronger in men.
6. The negative association between GFP and sexual desire for others will be stronger in women, while the positive association between DT and sexual desire for others will be stronger in men.

Method

Participants and Data Collection

The data used in this study were collected as a part of a large commercial questionnaire survey. McCann Erickson recruited the respondents from various areas of United Kingdom (North = 32%, Midlands = 30%, and South = 38%). The original sample was composed of 1003 British women and men, and after excluding respondents who reported themselves as not exclusively heterosexual, not in romantic relationships, or who had missing data, the sample size was reduced to 598. There were 288 females (M_{age} = 37.89 year-old, *SD* = 8.57, 95% CI [36.89, 38.88]) and 310 males (M_{age} = 40.67 year-old, *SD* = 8.56, 95% CI [39.72, 41.63]) aged between 25 and 55year-old. Among them, 66% were married (or remarried), 24% were cohabiting with their partners, and 10%were in serious dating relationships.

Measures

The questionnaire was composed of seven parts: demographic measures; romantic love scale; adult attachment scale; sexual desire for a partner scale; sexual desire for others scale; the Big Five Inventory scale (for GFP); and the Dirty Dozen scale (for DT). Appendices E, F, and G display items for the relationship dimensions scales, GFP scale, and DT scale, respectively. For the romantic love, adult attachment, and two sexual desire scales, participants were instructed to think about their current intimate relationship. The raw scores on each item in the measures were summed and averaged to create a single variable for each scale.

Demographic measure. The participants' geographic residence, gender, age, sexual orientation, and relationship status (e.g., single, dating, cohabiting, married) were reported.

Romantic love scale. Five items were taken from 30-item Passionate Love Scale (Hatfield & Sprecher, 1986). Items were chosen to represent the following domains: *Intrusive thinking*, *Idealization of a partner or relationship*, *Desire to know a partner and be known*, and *Negative feelings when the relationship goes wrong*. The respondents recorded their agreement with each statement on a 5-point Likert scale, where 1 = 'Disagree strongly' and 5 = 'Agree strongly'.

Adult attachment scale. There were six 5-point Likert items on the adult attachment scale. The items were designed to measure the six domains of adult attachment: *Care-receiving/safe-haven*; *Care-receiving/secure-base*; *Care-giving/safe-haven*; *Care-giving/secure-base*; *Proximity seeking*; and *Separation distress*. These domains were based on attachment theory (Ainsworth, 1967; Ainsworth, 1985; Bowlby, 1958; Bowlby, 1969) and selected and/or modified from existing measurements (WHOTO scale; Hazan & Zeifman, 1994; PLS; Hatfield & Sprecher, 1986; Romantic Attitude Rating Scale; Pedersen & Shoemaker, 1993; Affective Relationship Scale; Takahashi & Sakamoto, 2000; Attachment Features and Function Scale; Tancredy & Fraley, 2006). Possible responses to each item ranged from 1 = 'Disagree strongly' to 5 = 'Agree strongly'.

Sexual desire scales. There were two sexual desire subscales: *Sexual desire for a partner* scale and *Sexual desire for others* scale. Each subscale had two items taken from the Sexual Desire Inventory (SDI; Spector, Carey, & Steinberg, 1996) measuring frequency and intensity of desire. Items were modified to measure sexual desire for a partner and others. The frequency items ("In a typical month, how often would you have liked to engage in sexual activity with your partner / a person you find attractive?") had an 8-point Likert response scale (1 = 'Not at all' to 8 = 'More than once a day'). The intensity items ("How strong is your desire to engage in sexual activity with your partner? /a person you find attractive?") had a 5-point Likert-response scale (1= 'No desire' to 5 = 'Very strong desire').

General Factor of Personality scale. The Big Five Inventory-10 (BFI-10; Rammstedt & John, 2007) is a short version of the full Big Five Inventory (John, Donahue, & Kentle, 1991). The BFI-10 was used to assess the five dimensions of personality (*Extraversion*, *Agreeableness*, *Conscientiousness*, *Neuroticism*, and *Openness).* The scale originally correlated highly with the full BFI and showed good convergent validity with another measurement of the Big Five dimensions (NEO-PI-R;Costa, & McCrae, 1992b) and test-retest reliability (see Rammstedt & John, 2007). Conscientiousness was assessed by three items (as recommended by Rammstedt & John,

2007) and the remainder by two items. Respondents recorded how well each statement described their personality on a 5-point Likert scale, where 1 = 'Disagree strongly' and 5 = Agree strongly'. The total neuroticism score was re-calculated as emotional stability by inverting the scores.

Dark Triad scale. The Dirty Dozen scale (Jonason & Webster, 2010) was used to measure the Dark Triad. The scale originally showed acceptable discriminant validity with the Single-Item Self-Esteem Scale (Robins, Hendin, & Trzesniewski, 2001), convergent validity with other measurements relevant to DT (e.g., the Aggression Questionnaire; Buss & Perry, 1992), and test-retest reliability (see Jonason & Webster, 2010). It is a 12-item scale on which four items assess each of the three sub-dimensions of the Dark Triad (*Machiavellianism*, *Psychopathy*, and *Narcissism*). The respondents recorded their agreement or disagreement with each statement.

Overview of Statistical Analyses

Confirmatory factor analysis (CFA) was used to test how well the four factor conceptualization of pair-bond relationships (i.e., romantic love, attachment, and sexual desires for a partner and others) fitted the data. Cronbach's alphas (α) were calculated for each scale to estimate internal reliabilities. Correlations between relationship and personality variables were computed to examine inter-relationships among variables. Sex differences on each scale and sub-scale of personality measures were analysed by analysis of variance (ANOVA).

Moderated multiple regression (see Frazier, Tix, & Barron, 2004) was used to assess whether the relationships between predictor variables (GFP and DT) and outcome variables (romantic love, attachment, sexual desire for a partner, and sexual desire for others) differed as a function of respondent' sex. The presence of a significant product term involving sex of respondent, for example, indicates that the relationship between the predictor and outcome variable may be true for only one sex, true for both sexes but with a stronger effect in one sex, or that the sexes show opposite signs with respect to the valence of the relationship. As there were a large number of analyses, I focus on reporting significant effects.

Results

Confirming the Factor Structure

A four-factor structure (romantic love, attachment, sexual desire for a partner and others) was tested to see how well the structure fitted the present data (allowing for correlated factors). The comparative fit index (CFI) and the goodness of fit index (GFI) were close to .95 (CFI = .91; GFI = .92), which indicated that the model fit was

reasonably good (Hu & Bentler, 1999). Root mean square error of approximation (RMSEA) was .08 with 90% CI [.07, .08], indicating acceptable model fit (Browne & Cudeck, 1992). The chi-square test of goodness-of-fit showed that the model and the actual data were significantly different, χ^2 (84) = 371.82, p < 001; however, chi-square is generally recognised to be an over-stringent fit criterion being highly sensitive to sample size (Albright & Park, 2009; Jöreskog, 1969) . Although these results suggested that the observed data fitted acceptably to the four-factor model, CFA diagnostics indicated that the deletion of item 1 *(Intrusive thinking)* from the romantic love scale would improve the model fit: χ^2 (71) = 241.23, p < 001; CFI = .94; GFI = .95; and RMSEA = .06 with 90% CI [.06, .07]. Hence, this item was removed from the romantic love scale.

Scale Reliabilities

The internal consistency for each scale was as follows: the romantic love scale (four items: α = .71); the adult attachment scale (six items: α = .84); the sexual desire for a partner scale (two items: α = .60); the sexual desire for others scale (two items: α = .71); the GFP scale (11 items: α = .59); and the DT scale (12 items: α = .73). The α value around .80 is a commonly accepted desirable value for satisfactory internal consistency (e.g., Bland & Altman, 1997; Streiner, 2003). According to this criterion, the scale reliabilities were low for the sexual desire for a partner and GFP scales. The lower internal reliabilities might compromise the ability to detect correlations and group differences.

Correlations between Relationship and Personality Traits Scales

Table 1 displays the correlations between four relationship dimensions and two personality scales. Regarding the association between GFP and DT (prediction 1), there was no significant correlation between GFP and DT, r = -.04, p =.37. Despite their opposing valence in terms of prosocial and antisocial orientation to others, the two traits were independent of one another. Regarding the associations between relationship and personality variables, a cluster of positive correlations between romantic love, attachment, partner-directed sexual desire, and GFP were expected, given their hypothesized (positive) link with the slower life history dimension (prediction 2). As expected, GFP was positively correlated, albeit weakly, with partner-directed feeling of romantic attraction, r = .10, p < .05, attachment, r = .10, p < .05, and sexual desire for partner, r = .22, p < .01. However, unexpectedly, GFP was uncorrelated with sexual desire for others, r = .001, p = .99. DT and sexual desire for others were expected to be positively correlated, given their hypothesized (positive) link with the faster life history dimension (prediction 3). As predicted, DT was positively correlated with sexual desire for others, r = .21, p < .01 and negatively correlated with partner-directed feeling of attachment, r = -

.12, $p < .01$. However, unexpectedly, DT was not significantly associated with romantic love, $r = -.05$, $p = .24$, or sexual desire for a partner, $r = .06$, $p = .12$. In addition, there was a positive correlation between the two sexual desire variables suggesting that these may represent a general measure of sexual drive.

Table 1

Correlations between Variables for the Overall Sample

Variables	RL	AA	SexP	SexO	GFP	DT
Romantic love (RL)	-	.69**	.30**	-.10*	.10*	-.05
Adult attachment (AA)		-	.23**	-.22**	.10*	-.12**
Sexual desire: partner (SexP)			-	.16**	.22**	.06
Sexual desire: others (SexO)				-	.001	.21**
GFP					-	-.04

Note. $N = 598$. * $p < .05$. ** $p < .01$.

Sex Differences

One-way ANOVAs were performed to analyse the effect of participants' sex on the six relationship dimension and personality scales (romantic love, adult attachment, sexual desire for a partner and others, GFP, and DT). Sex differences were also examined on sub-scales of GFP (Extraversion, Openness, Agreeableness, Conscientiousness, and Emotional stability), and DT (Machiavellianism, Psychopathy, and Narcissism). For every analysis, the assumption of homogeneity of variance was met. Outliers were identified in the romantic love, GFP, and conscientiousness scales, in which the total sample size decreased from 598 to 596 (one male and one female from romantic love and GFP analyses; two females from conscientiousness analysis).

According to conventional sex role theory, men are expected to show higher sexual desire and DT scores, together with lower GFP scores and levels of partner-directed feelings of attachment (prediction 4). There were medium to large effects of respondent sex on sexual desire for a partner, $F(1, 596) = 15.57$, $p < .001$, $d = 0.32$, and sexual desire for others, $F(1, 596) = 100.35$, $p < .001$, $d = 0.81$, with a much stronger effect for sexual desire for others. Table 2 shows that men scored significantly higher than women on both scales. Unexpectedly, sex differences were absent in adult attachment, $F(1, 596) = 0.32$, $p = .57$, $d = 0.06$, GFP, $F(1, 594) = 0.26$, $p = .61$, $d = 0.04$,

and DT, $F(1, 596) = 1.84$, $p = .18$, $d = 0.11$. There was also no significant sex difference in romantic love, $F(1, 594) = 0.23$, $p = .63$, $d = 0.06$.

With regard to GFP sub-scales, there was a significant effect of sex on conscientiousness, $F(1, 594) = 3.71$, $p < .05$, $d = 0.16$, and on emotional stability, $F(1, 596) = 15.11$, $p < .001$, $d = 0.32$, with men scoring significantly lower on conscientiousness and higher on emotional stability. Regarding DT sub-scales, there was a significant sex difference only on psychopathy, $F(1, 596) = 11.35$, $p < .001$, $d = 0.28$, with men scoring higher than women (Table2).

Table 2

Means, Standard Deviations, and 95% Confidence Intervals (CIs) for Scores on Relationship and Personality Traits Measures

Scales	Men		Women	
	M (SD)	95% CI	*M (SD)*	95% CI
Relationship scales				
Romantic love	3.92 (0.69)	3.85, 4.00	3.95 (0.72)	3.87, 4.04
Adult attachment	4.28(0.62)	4.22, 4.35	4.31(0.63)	4.24, 4.39
Sexual desire for a partner	4.44 (1.12)	4.31, 4.56	4.06 (1.21)	3.92, 4.20
Sexual desire for others	3.21 (1.59)	3.03, 3,38	2.01 (1.31)	1.85, 2.16
GFP and its subscales				
GFP	3.43 (0.44)	3.38, 4.48	3.41 (0.43)	3.36, 4,36
Extraversion	2.91 (0.92)	2.81, 3.01	3.01 (0.90)	2.90, 3.11
Openness	3.60 (0.82)	3.51, 3.69	3.63 (0.81)	3.53, 3.72
Agreeableness	3.64 (0.56)	3.58, 3.71	3.63 (0.63)	3.55, 3.70
Conscientiousness	3.72 (0.75)	3.64, 3.81	3.84 (0.75)	3.75, 3.93
Emotional stability	3.19 (0.93)	3.09, 3.30	2.90 (0.91)	2.80, 3.01
DT and its subscales				
DT	0.35 (0.21)	0.33, 0.37	0.33 (0.22)	0.30, 0.35
Machiavellianism	0.41 (0.30)	0.37, 0.44	0.37 (0.29)	0.33, 0.40
Psychopathy	0.29 (0.24)	0.26, 0.31	0.22 (0.22)	0.20, 0.25
Narcissism	0.35 (0.33)	0.32, 0.39	0.39 (0.33)	0.35, 0.43

Note. Men ($n = 309$) and women ($n = 287$) for romantic love and GFP, men ($n = 310$) and women ($n = 286$) for conscientiousness, and men ($n = 310$) and women ($n = 288$) for rest of the scales.

Possible Moderation Effects of Sex on the Associations between Relationship and Personality Traits Measures

Moderated multiple regression (MMR) was used to examine whether sex moderated the associations between relationship and personality traits variables. In order to form regression equations, 'sex' was coded as 1 for male and -1 for female (unweighted effect coding). Next, the continuous predictors (GFP and DT) were centered for each sample by subtracting mean scale scores from raw scale scores. Third, product terms were formed to represent interaction terms. It is recommended that no interaction should be entered in models unless based on strong theoretical expectations (Frazier et al., 2004). Because the current study makes no predictions about a two-way interaction between personality traits (GFP × DT) or about a three-way interaction (Sex × GFP × DT), these product terms were not formed. Finally, equations were structured. The first-order effect variables (Sex, GFP, and DT) were entered in the first step and the two-way product terms (Sex × GFP and Sex × DT) in the second step. The analyses were performed separately for each outcome variable (romantic love, attachment, and sexual desire for a partner and others).

Prior to undertaking the analyses, the assumptions for MMR were also checked. No variables were correlated above $r > .69$ (including correlations between the product terms), which indicated the absence of collinearity. The assumptions of homoscedasticity, independence of errors, and multivariate normality were not violated. Sample size and error variance across both sexes were roughly equal which met the assumptions of MMR. Note that throughout the present paper, I only reported unstandardized regression coefficient, because standardized regression coefficients in MMR are improperly standardized and thus are not interpretable (Aiken & West, 1991). The effects of sex on relationship variables were reported previously in the analysis of sex differences; therefore, it will not be mentioned here unless it shows different patterns from the previous analyses. Table 3 displays the final model (step 2) for romantic love, adult attachment, and sexual desire for a partner and others.

Romantic love. It was expected that GFP would be positively and DT would be negatively predict romantic love (Prediction 2). After removing one outlier, the sample size dropped from 598 to 597. The first model showed that adjusted R^2 for the first-order predictors (Sex, GFP, and DT) was significantly different from zero, $F(3, 593) = 2.90$, $p < .05$,although the magnitude of the effect was small (adjusted $R^2 = .01$). Only GFP ($t = 2.51$, $p < .05$) significantly and positively accounted for variance in the romantic love scores. This showed that GFP positively predicted romantic love as expected (Prediction 2). However, contrary to Prediction 2, DT did not significantly and negatively predict romantic love. In the second step, the change in adjusted R^2 (adjusted ΔR^2) for two-way product terms (Sex × GFP and Sex × DT) was .002 which was not

significant, $\Delta F(2, 591) = 0.13$, $p = .88$. This indicated that sex of respondents did not moderate the effect of personality on romantic love.

Adult attachment. It was expected that GFP would be positively and DT would be negatively predict adult attachment (Prediction 2). This positive association between GFP and adult attachment was expected to be stronger in women while the negative association between DT and adult attachment was expected to be stronger in men (Prediction 5). The sample size dropped from 598 to 597 after removing one outlier. The first model was significant, $F(3, 593) = 5.50$, $p < .01$,although again the magnitude of the effect was small (adjusted $R^2 = .02$). In support of Prediction 2, GFP ($t = 2.63$, $p < .01$) and DT ($t = -2.96$, $p < .01$) accounted for significant variance (positively and negatively respectively) in the adult attachment scores. The second model was not significant, adjusted $\Delta R^2 = .002$, $\Delta F(2, 591) = 1.49$, $p = .23$. This indicated that, contrary to Prediction 5, sex of respondents did not moderate the effects of personality on adult attachment.

Sexual desire for a partner. It was expected that GFP would be positively and DT would be negatively predict partner-directed sexual desire (Prediction 2). The sample size was 598 with no outliers detected. The first model was significant, $F(3, 594) = 16.54$, $p < .001$, although the magnitude of the effect was small (adjusted $R^2 = .07$). Sex ($t = 3.84$, $p < .001$) and GFP ($t = 5.59$, $p < .001$) accounted for a significant amount of variance in the sexual desire for a partner scores. This showed that, as expected (Prediction 2), GFP positively predicted partner-directed sexual desire. However, contrary to Prediction 2, DT did not significantly predict sexual desire for a partner. The second model was not significant, adjusted $\Delta R^2 = .002$, $\Delta F(2, 592) = 0.29$, $p = .75$. This indicated that sex of respondents did not moderate the effect of personality on sexual desire for a partner.

Sexual desire for others. It was expected that GFP would be negatively and DT would be positively predict sexual desire for others (Prediction 3). This negative association between GFP and sexual desire for others was expected to be stronger in women while the positive association between DT and sexual desire for others was expected to be stronger in men (Prediction 6). The sample size was 598 with no outliers detected. The first model was significant, adjusted $R^2 = .18$, $F(3, 594) = 43.10$, $p < .001$. Sex ($t = 9.91$, $p < .001$) and DT ($t = 5.0$, $p < .001$) accounted for a significant amount of variance in sexual desire for others. This showed that, as expected (Prediction 3), DT positively predicted other-directed sexual desire. However, contrary to Prediction 3, GFP did not significantly predict desire for others. Contrary to Prediction 6, the second model was not significant, adjusted $\Delta R^2 = -.002$, $\Delta F(2, 592) = 0.35$, $p = .71$, indicating that sex of respondent did not moderate the effect of personality on sexual desire for others.

Table3

Multiple Regression Analyses Predicting Romantic Love, Adult Attachment, Sexual Desire for a Partner and Others from Participants' Sex and Personalities

Step2	Romantic love		Attachment		Sexual desire: partner		Sexual desire: others	
$_{adj}\Delta R^2$	.01		.02		.07		.17	
Predictor	*B*	*SE B*	*B*	*SE B*	*B*	*SE B*	*B*	*SE B*
Sex	-0.02	0.03	-0.01	0.03	**0.18*****	0.05	**0.58*****	0.06
GFP	**0.17***	0.07	**0.14****	0.06	**0.59*****	0.11	0.004	0.13
DT	-0.18	0.14	**-0.35****	0.12	0.36	0.22	**1.38*****	0.28
Sex×GFP	-0.002	0.07	0.07	0.06	-0.08	0.11	-0.05	0.13
Sex×DT	0.07	0.14	0.15	0.12	-0.04	0.22	-0.21	0.28

Note. $N = 597$ for romantic love and adult attachment and $N = 598$ for sexual desire for a partner and others. Sex was coded as male = 1 and female = -1. GFP and DT were mean centered for each sample. * $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

Using the life history theory approach, I investigated associations between the personality traits (GFP and DT) and the dimensions of heterosexual relationships (romantic love, adult attachment, and sexual desire for a partner and others), and whether these relations differ between men and women in the British adult population.

The Association between GFP and DT

Although GFP and DT were suggested to correspond respectively to the slower and faster ends of the single life history continuum (Jonason et al., 2010; Rushton et al., 2008), GFP and DT did not show a significant negative correlation (Prediction 1). The absence of significant correlation between the two personality traits indicates that they are orthogonal rather than opposing traits. The null correlation found in the present study supports previous suggestions that DT is a distinct personality type that is not captured by (correlated with) the Big Five (Jonason & Webster, 2010). In this case, one would conclude that individual differences in qualities such as Machiavellianism, psychopathy, and narcissism are independent of qualities such as extraversion, emotional stability, openness, agreeableness and conscientiousness. Indeed, a recent study examining correlations between the DT subtraits and the Big Five found a mixed pattern of correlations varying in sign and significance (Veselka, Schermer, & Vernon, 2012). There are two possible explanations for this finding. One invokes a measurement problem in one or both of these measures. If the scales do not adequately capture the underlying construct they intend to measure, then their lack of correlation derives from a

problem of construct validity. However there is a body of evidence testifying to the expected correlations between these scales and a range of predicted variables (e.g., Jonason,Li, Webster & Schmitt, 2009; Jonason & Webster, 2010; Loehlin, 2012; van der Linden et al., 2012). A second issue concerns the extent to which these measures are associated with life history outcomes. Life history theory originated in the biological sciences and examined the timing and organization of a range of observable morphological and behavioural variables. GFP and DT are measures of personality traits which have been hypothesized to mediate (or at least correlate with) life history tempo. This hypothesis could be directly tested by measuring key life history events as indicated (e.g., age of puberty, number of sexual partners, number of children, age of death). Although associations between DT and some mating variables have been examined (e.g., short-term mating strategy; Jonason et al., 2009), there has been little attempt to comprehensively demonstrate that these psychological traits show consistent associations with biologically relevant life events (Copping, Campbell, & Muncer, 2014). Hence, GFP and DT may represent two personality traits that the present data show to be associated with relationship measures, but they may not be good proxies for life history strategy when this is interpreted more broadly to include age of puberty, number of offspring, and life expectancy.

The Associations between Personality Traits and Relationship Dimensions

I examined associations between personality traits (GFP and DT) and aspects of pair bond relationship (romantic love, attachment, and sexual desire). The traditional life history framework proposes that individuals face a trade-off between mating and parental effort (reviewed in Kaplan & Gangestad, 2005). However there seems to be a lack of consensus in the definition of mating effort; the term has sometimes been used without specifying the target of sexual desire (e.g., Low, 1978; Rushton, 1985) or defined as effort to obtain short-term mates (e.g., Figueredo et al., 2004; Rowe et al., 1997). In order to avoid conceptual confusion, I divided mating effort into a pair-bond context and a short-term extra-pair context. Based on these concepts, adult attachment (as parenting effort), romantic love (as an emotional side of pair-bond mating effort), and sexual desire for a partner (as mating effort in a pair-bond context) were anticipated to be positively associated with the slower life history dimension (thus with GFP). Sexual desire for others (as mating effort in a short-term context) was expected to be positively associated with the faster life history dimension (thus with DT).

As expected (Prediction 2), a cluster of positive correlations between romantic love, adult attachment, sexual desire for a partner and GFP was found, together with a positive correlation between sexual desire for others and DT and a negative correlation between adult attachment and DT. GFP and DT were shown to be orthogonal traits;

hence, these two clusters of positive associations (GFP with romantic love, attachment, and sexual desire for a partner; DT with sexual desire for others) can be considered as distinctive dimensions rather than opposite poles of a unitary life history continuum. If this is the case, the present findings may indicate that GFP is index of pair-bond mating and parental effort while DT is index of short-term mating effort, respectively. This was supported by regression analyses which showed that GFP positively predicted romantic love, adult attachment, and partner-directed sexual desire, while DT negatively predicted adult attachment and positively predicted sexual desire for others. In fact, the positive link between GFP and partner-directed sexual desire is a notable finding in the present study as this link has not been considered in previous studies (e.g., Rushton, 1985). This implies that it may be important to separate mating effort in pair-bond relationships versus extra-pair short-term contexts.

Overall, the present study suggested that GFP may support exclusive pair-bond relationships whereas DT may support short-term extra-pair relationships. However, as already noted, GFP and DT were shown to be orthogonal in the present study. In line with the notion that the trait expression can be context-dependent (e.g., Mischel, 2004), individuals may be able to possess both GFP and DT personality traits and thus their mating patterns will be jointly influenced by both these traits. For instance, individuals with higher GFP may have a tendency to form and maintain exclusive pair-bond relationships, but the level of GFP and a propensity to form short-term relationships are independent of each other. Indeed, in the current study, GFP was not significantly correlated with and did not predict sexual desire for others, and DT was not significantly correlated with and did not predict romantic love and sexual desire for a partner. Similarly, a large cross-cultural study (Schmitt, 2005a) also showed that short-term mating strategies were unrelated to three sub-scales that contribute to GFP (agreeableness, extraversion, and emotional stability).

Furthermore, to the extent that GFP and DT are proxies for the tendency to form long-term versus short-term relationships, the absence of a negative association between them is problematic for life history theories that characterize these two strategies as mutually exclusive alternatives. While Rushton (1985) argued for a genetic basis to strategy selection, others proposed that early childhood environments channel individuals to either long- or short-term strategies (e.g., Belsky, Steinberg, & Draper, 1991; Chisholm, 1996), or that weak attachment bonds to parents lead individuals to develop antisocial personalities which militate against the formation of stable pair-bond relationships in adulthood (e.g., Bowlby, 1980; Miller & Fishkin, 1997). Although the basis of strategy choice was not examined in the present study, the lack of correlation between GFP and DT may indicate that individuals can flexibly use both long- and short-term mating

strategies (Buss & Schmitt, 1993) rather than genetic or developmental factors leading to the adoption of one or the other.

Sex Differences

The conventional sex role argument predicts that males invest more in mating effort whereas females invest more in parenting effort (e.g., Trivers, 1972) and consequently males are expected to have a stronger sex drive than females (e.g., Baumeister, Catanese, & Vohs, 2001). Hence, men were predicted to show greater sexual desire (for both partners and others) and higher DT scores than women. Women were expected to show greater adult attachment and GFP (Prediction 4). In line with the conventional sex role view (and Prediction 4), men scored significantly higher than women on sexual desire for partners and others, with a medium effect size for the former and a large effect size for the latter. This suggests that men exceed women most markedly in their desire for extra-pair partners, and may be more likely to respond to opportunities for short-term relationships as predicted by the conventional sex role view. It is important to note that a strong sexual desire for others may not directly predict men's actual pursuit of short-term relationships, because sexual desire is distinguishable from physiological sexual arousal and behaviours (Pfaus, 2009; Regan, 1996). Although men may be more likely to experience sexual desire in response to sexual stimuli, inhibitory mechanisms can suppress sexual excitation if putting desire into action is contrary to achieving other goals (MacDonald, 2008; Pfaus, 2009), such as the maintenance of pair-bond relationships.

No sex differences were found in romantic love, adult attachment, GFP, and DT. In fact, the only significant sex difference found in the current study was in partner-and other-directed sexual desire. This finding might support suggestions that men and women are more alike than different in most psychological traits (Hyde, 2005; Stewart-Williams, 2013). Indeed, the absence of sex difference in romantic love is consistent with previous work (Hatfield & Sprecher, 1986; Rubin, 1970). Heffernan, Fraley, Vicary, and Brumbaugh (2012) also showed sex similarities in the process of attachment bond development between romantic partners, implying that the degree of attachment may be similar in the two sexes as well. These results indicate that romantic love and attachment systems operate with equal strength in men and women.

Regarding personality traits, the findings are in contrast to previous research showing that men score lower on K-factor (Figueredo et al., 2005) and higher on DT (e.g., Jonason et al., 2013, 2009). These studies reported significant sex differences using university students as participants, whereas the sample in the present study is composed of a relatively older and wider range of relationship types. It is possible that younger single men may be more prone to exhibit qualities such as the faster life history strategies

indicated by lower GFP, and egocentrism, sensation seeking, lack of empathy and inflated sense of self-worth that are tapped by the Dark Triad constellation. Indeed, these qualities may form a part of the confrontational 'young male syndrome' described by Wilson and Daly (1985). Future work examining the longitudinal trajectory of DT and GFP across the life course could determine whether these traits are age-related, declining as individuals (especially men) mature.

The absence of sex differences in GFP raises questions about the concept and measurement of a single higher-order personality trait. GFP, in this study as in others, was derived by simple summation of scores on the Big Five dimensions. This may conceal meaningful and evolutionarily relevant sex differences (Muncer, 2011). The present data and those of others indicate that men and women score differently across the five personality factors (Costa, Terracciano, & McCrae, 2001; Schmitt et al., 2008). Summing them to produce an aggregate score eliminates these important differences. The statistical rationale for doing so rests on confirmatory factor analysis in which a latent higher-order factor is introduced to the model. Muncer (2011) has demonstrated that this adds nothing to a simpler two-factor model composed of Alpha (Conscientiousness, Emotional stability, and Agreeableness) and Beta (Extraversion and Openness to Experience). There are good evolutionary reasons for expecting sex differences on lower level factors. For example, Campbell (1999) has proposed that anxiety and fear are higher in women as a function of the need for mothers to be alert to dangers to themselves and their offspring. Cross-culturally, women do indeed score higher than men on neuroticism (especially anxiety and vulnerability facets), and men score higher on assertiveness and excitement-seeking facets of extraversion in line with the adaptive advantages of intra-male competition (Costa et al., 2001). In the present study, women scored higher than men on both neuroticism (inverted emotional stability) and conscientiousness (which includes facets of self-discipline and deliberation). By summing over these differences, the presumption is that evolution has shaped a 'general' personality type without reference to the distinctive reproductive roles of the two sexes (Muncer, 2011). The current finding that GFP is invariant across sex may mask sex differences that are important in terms of mate selection and reproductive strategy.

The Lack of Moderation Effect by Sex

Given women's hypothesized propensity for allocating more energy to parental effort and men's hypothesized propensity for allocating more energy to short-term mating effort (e.g., Trivers, 1972), the correlation between GFP and parental effort (adult attachment) was expected to be stronger in women while the negative correlation between DT and parental effort was expected to be stronger in men (Prediction 5). The negative association between GFP and short-term mating effort (sexual desire for others) was

predicted to be greater in women whereas the positive association between DT and short-term mating effort was predicted to be greater in men (Prediction 6). However, in the present study, the associations between personality traits and relationship variables were not moderated by sex. GFP may support exclusive pair-bond relationships whereas DT may support short-term extra-pair relationships, but these associations did not differ for men and women. This implies that individual differences in life history strategy induced by biological sex and broad personality traits (GFP or DT) are independent of each other. The present data cast doubt on the extent to which DT constitutes the psychological mechanism underlying a specifically 'male' mating strategy (Jonason et al., 2009). The absence of moderation by sex invites further consideration of its role in women's mating strategy (Carter, Campbell, & Muncer, 2014).

Limitations and Conclusion

Only the adult attachment scale had a high level of internal consistency ($\alpha > .80$). Low alpha values may be due to having few items for each scale. However, in order to increase the sample size, it was important to make the questionnaires as short as possible. Weak internal consistency (associated with random error) can suppress correlations and hence underestimate the true relationship between variables.

The present study showed that GFP is associated with exclusive pair-bond relationships, whereas DT may enhance attraction to extra-pair partners However, contrary to predictions, GFP and DT were shown to be orthogonal traits, implying that they might not serve well as indicators of a single life history dimension, and there might be more than one dimension underlying individual differences in life history strategies. In another word, fast and slow life history strategy may not be mutually exclusive strategies. Regarding sex differences, in line with the conventional sex role argument, men showed greater sexual desire than women both for partners and others. On the other hand, the lack of sex differences in personality traits and affective aspects of romantic relationships indicates that sex role divergence in the present sample of British participants did not conform to conventional sex role predictions. This indicates that personality traits proposed to be associated with life history tempo and emotions associated with romantic relationship are not differentiated by respondent sex.

Chapter Six
The Effect of Menstrual Cycle Phase

Introduction

Sexual strategies theory proposes that both sexes have evolved a set of distinct *long*- and *short-term* mating strategies, which solve different reproductive problems (Buss & Schmitt, 1993). Note that, in this chapter, I will use the terms 'long-term' to refer to pair-bond relationships, and 'short-term' to refer to extra-pair sexual intercourse or any form of uncommitted relationships. This chapter will focus on women's short-term strategies.

Women's Mate Choice Trade-offs

Reproductive success is achieved by producing offspring that reach reproductive age and leave descendent (Darwin, 1859). Ancestral women's reproductive success depended on acquiring direct resources necessary to support them and their offspring, as well as on acquiring indirect genetic benefits from male partners (Buss & Schmitt, 1993). Thus, theory predicts that females have evolved mate preferences for male traits associated with ability and willingness to devote resources directly to their partners and their offspring (Buss & Schmitt, 1993). Indeed, a cross-cultural study showed that women, relative to men, rated partners' good financial prospect and ambitiousness higher (Buss, 1989). On the other hand, the good genes hypothesis proposed that producing offspring with a man with masculine features and with higher facial symmetry might indirectly increase fitness for a woman by producing high quality descendants. Masculine features and male facial symmetry are believed to be driven by testosterone (e.g., Gangestad & Thornhill, 2003); however, higher testosterone levels might be costly as they may suppress the immune system (Folstad & Karter, 1992). The good genes hypothesis argues that exaggerated male features might reflect high genetic quality, because males who can develop such features under the immunosuppressive effects of high testosterone must have good overall quality (e.g., Zahavi, 1975). The hypothesis therefore predicts that women may have evolved sexual preferences for men with masculine features and higher facial symmetry.

Women with high mate value might be able to secure both resources and good genes from the same male partner. Indeed, a study showed that more physically attractive women had higher standards for long-term male partners (Buss & Shackelford, 2008). However, men with indicators of good genes, and thus who are more sexually attractive, are more likely to successfully seek multiple sexual partners, as opposed to forming a stable pair-bond (Gangestad & Simpson, 2000). Consequently, ''the best sires may not be the best providers'' (p. 56), and women sometimes might need to make mate choice

trade-offs between *investing* primary partners and *physically attractive* extra-pair partners (Pillsworth, Haselton, & Buss, 2004). Under some conditions, therefore, a beneficial strategy would be to secure the resources and assistance of a primary partner (i.e., long-term mating strategy), while engaging in extra-pair copulations with more physically attractive men to increase the genetic quality of resulting offspring (i.e., short-term mating strategy) (Gangestad & Simpson, 2000).

Both long- and short-term mating strategies carry costs and benefits. Forming a stable pair-bond might enhance women (and men)'s reproductive success by bringing sustained and mutual commitment and thus increasing offspring survival (Lovejoy, 1981). However, poor long-term mate choices could be costly in terms of opportunity costs and wasted heavy investment (Buss, 2002). Having extra sexual partners may benefit women directly by gaining temporary material resources (Greiling & Buss, 2000) or/and indirectly by genetic benefits (Gangestad, Thornhill, & Garver-Apgar, 2005a), beyond her current primary partner. The costs of short-term mating strategies include the increased risks of damaging one's social reputation, sustaining violence from jealous primary partners or same-sex rivals, and contracting sexually transmitted diseases (reviewed in Buss & Schmitt, 1993). Given these costs and benefits of mating strategies, individuals should select a mating strategy when the benefits of that strategy outweigh the costs, and the net utility is greater than that of other strategies (Buss & Schmitt, 1993; Buss, 2002). Allocation of resources to reproductive problems needs to be efficient and effective, because available resources and lifespan of each individual are finite (reviewed in Kaplan & Gangestad, 2005). Thus, decisions about mating strategies should be highly sensitive to individual circumstances (e.g., one's own mate value, sex ratio in a population, and cultural norms) (Buss & Schmitt, 1993; Buss, 2002).

Ovulatory Shift Hypotheses

According to the ovulatory shift hypotheses, females (and males) evolved psychological propensities to be sensitive to conception probability (Gangestad et al., 2005b). Both non-human and human females may have evolved to experience greater sexual desire when they are most likely to conceive (i.e., near ovulation) in order to motivate copulations and to increase the likelihood of conception (Riley, Riley, & Brown, 1986; Wallen, Winston, Gaventa, Davisdasilva, & Collins, 1984). Furthermore, the ovulatory shift in the intensity of sexual desire might occur selectively towards particular males (Gangestad & Thornhill, 1998). This selective cycle phase effect was found both in non-human and human females, which indicates that the ovulatory shift adaptation occurred before the emergence of genus *Homo*. For example, although female chimpanzees generally mate promiscuously, studies showed that they were more selective (Stumpf & Boesch, 2004) and mated frequently with higher-ranking males (Matsumoto-

Oda, 1999) when the conception probability was greatest. With regard to selective cycle phase effect in human females, currently there are two different perspectives.

The good genes ovulatory shift hypothesis. Decisions about mating should be highly context-dependent, and individuals might pursue extra-pair sexual partners if doing so benefits them directly (e.g., material benefits) or/and indirectly (genetic benefits). Women (and men) are able to gain genetic benefits only when conception actually occurs whereas gaining direct benefits is not restricted by women's fertility status. The good genes ovulatory shift hypothesis argues that women near ovulation experience increased sexual desire towards men with indicators of good genes (higher masculinity and facial symmetry) and are inclined to engage in short-term sexual relationships with such men (Gangestad & Thornhill, 1998; Gangestad et al., 2005b). Many studies have shown that women in their fertile phase find men's masculine traits and facial symmetry more attractive. These traits include, for instance, scent of symmetrical men (Gangestad & Thornhill, 1998), masculine faces (Penton-Voak et al., 1999), behaviours indicating intrasexual competitiveness (Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004), and low male voice pitch (Puts, 2005).

The good genes ovulatory shift hypothesis further predicts that the trade-off between the extra-pair copulations for good genes and the costs of losing primary partners may only be advantageous for women paired with low quality men. If so, cycle phase effect on mating preferences will be most pronounced for women whose primary partners offer fewer genetic benefits for offspring (Gangestad et al., 2005a). Five studies have examined primary partner's physical attractiveness as a moderator of the cycle phase effect on attraction towards men, and results are contradictory. Gangestad et al. (2005a) showed that, on fertile compared with nonfertile days, women paired with less symmetrical men experienced greater sexual attraction towards extra-pair partners than towards their primary partners whereas women paired with more symmetrical men showed greater attraction to their primary partners than extra-sex partners. Pillsworth and Haselton (2006) showed that women paired with less physically attractive partners experienced higher sexual attraction towards extra-pair partners on fertile than nonfertile days. However, primary partner's investment attractiveness (desirability as a long-term mate) did not moderate this relation, and there was also no cycle phase effect on sexual attraction towards a primary partner. Haselton and Gangestad (2006) showed that, on fertile but not nonfertile days, women whose primary partners were low in sexual attractiveness relative to their investment attractiveness were more sexually attracted towards other men, but this effect was not found for women whose partners were sexually attractive but lower in investment attractiveness. Focusing on emotional closeness, Larson, Haselton, Gildersleeve, and Pillsworth (2013) found that, on fertile but not nonfertile days, women paired with men low in sexual desirability reported less closeness

towards them, while women paired with sexually desirable men felt closer to their partners.

The attachment bond ovulatory-shift hypothesis. Contrary to the good genes ovulation shift argument, Eastwick and Finkel (2012) proposed that the human adult attachment system evolved to counteract the increased attraction towards extra-pair partners during fertile days. In line with Fisher's (1998) hypothesis, they argued that in response to the need for biparental care, the ovulatory shift effect was re-shaped by a new selection pressure to suppress attraction towards extra-pair partners and enhance women's attention towards primary partners during fertile days in order to avoid a relationship crisis. Hence, it functions both to protect the pair-bond by diminishing attraction to extra-pair partners and further strengthens the attachment bond between partners. Eastwick and Finkel's study (2012) showed that, regardless of the level of primary partner physical attractiveness, women who were less attached to their primary partners had less intimate physical contacts with their primary partners during a fertile phase while women who were strongly attached to their primary partners had more intimate physical contacts with their partners during a fertile phase.

Indeed, humans evolved executive functions which allow us to anticipate consequences of our behaviours and intentionally inhibit impulse and desire to adhere to cultural and religious norms or to each individual's moral belief (e.g., Eastwick, 2009; MacDonald, 2008). Thus, an inhibitory mechanism might suppress the sexual excitatory mechanism in response to sexual stimuli specifically from extra-pair partners, while the sexual excitatory mechanism encourages further sexual excitement in response to sexual stimuli from primary partners. Researchers also proposed that humans evolved a psychological tendency to elevate attention towards their partner (an attention hypothesis) and/or deflect attention away from attractive others (a deflection hypothesis) (reviewed in Dunbar, 2012). For instance, studies showed that men and women in romantic relationships, compared to those not in relationships, were inclined to perceive opposite-sex individuals as less attractive (Simpson, Gangestad, & Lerma, 1990). Focusing on current partners or/and decreased interests in other potential partners may help individuals stay committed to each other.

Menstrual Cycle and Measurement Issues

The menstrual cycle is under the control of four primary hormones: follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and progesterone. During the bleeding period, FSH induces several ovarian follicles to grow. As these follicles grow, estrogen levels increase and this rise suppresses FSH and LH secretion to prevent the development of additional follicles. When a dominant follicle starts to mature, the increased level of estrogen and progesterone triggers LH surge, and then the follicle

releases a mature egg. After the ovulation, progesterone prepares for possible pregnancy. If conception does not occur, levels of progesterone and estrogen drop and bleeding occurs (reviewed in Silverthorn et al., 2007).

Hormonally-based methods are suggested to be the most reliable methods to identify the timing of ovulation (e.g., Persky et al., 1978). These methods include the measurement of LH (see later section), which was used by Gangestad et al. (2005a), Larson et al. (2013), and Pillsworth and Haselton (2006). Nevertheless, in the field of cycle phase studies, the backward counting method is most frequently used to estimate the date of ovulation by counting back 15 days from the next menstruation onset. This method was used by a number of studies such as Eastwick and Finkel (2012) and Haselton and Gangestad (2006). In line with the backward counting method, it is commonly believed that fertile days appear between days 10 and 17 in the 28-day menstrual cycle (Beckmann et al., 1998). However, one study showed that 70% of female participants experienced ovulation outside the fertility window, such as before day 10 or after day 17 (Wilcox, Dunson, & Baird, 2000). This indicates that ovulation timing can be remarkably variable between women, casting doubt on the accuracy of the backward estimation method.

Another problem is that there is no consensus as to how to divide a cycle and how many phases a cycle subsumes (Regan, 1996). In the field of cycle phase studies, researchers often partition cycle into just two phases; one is composed of several days that include the estimated day of ovulation (i.e., fertile phase) and the other includes days on which ovulation does not occur (i.e., nonfertile phase). This form of classification was used in Eastwick and Finkel (2012), Gangestad et al., (2005a), Haselton and Gangestad (2006), Larson et al. (2013), and Pillsworth and Haselton (2006) although the identification of which days were included in each phase and the number of those days differed across these studies. The lack of agreement about phase definition and duration mean that researchers could produce different cycle phase effects from the same dataset (e.g., Harris, 2011). Therefore, it is important for researchers to define each phase sufficiently clearly that studies can be compared.

The Current Study

The present study examines the two different ovulatory shift hypotheses: the good genes hypothesis and the attachment bond hypothesis. The present study also attempted to improve the quality of data relative to previous studies by: (1) collecting daily data for one complete menstrual cycle (or one complete contraceptive pill cycle) rather than comparing single days selected from dichotomous windows (fertile and non-fertile); (2) establishing the timing of the fertile phase by LH technique; (3) dividing the menstrual cycle into four phases (menstrual, ovulatory, follicular, luteal) rather than two

(fertile and non-fertile); (4) examining a wider range of romantic relationship-relevant dimensions (obsession, care-giving, care-receiving, separation distress, sexual desire for a partner and sexual desire for others); and (5) including a control group of women on hormonal contraceptives.

For the *good genes* ovulatory-shift hypothesis, predictions were as follows.

1. Naturally cycling women paired with less physically attractive men will experience increased sexual desire for other men and decreased obsession, care-giving, care-receiving, separation distress, and sexual desire for their partners during the ovulatory phase compared to during the menstrual, the follicular, and the luteal phases.
2. Naturally cycling women paired with more physically attractive men will show positive increases in obsession, care-giving, care-receiving, separation distress, and sexual desire for their partners and a decrease in sexual desire for others during the ovulatory phase compared to during the menstrual, the follicular, and the luteal phases.
3. Primary partners' investment attractiveness will not moderate the relationship between the cycle phase and obsession, care-receiving, care-giving, separation distress, and sexual desire for a partner and others.

For the *attachment bond* ovulatory shift hypothesis, predictions were as follows.

4. Regardless of primary partners' physical or investment attractiveness, naturally cycling women with a higher level of mutual commitment will report enhanced levels of obsession, care-giving, care-receiving, separation distress, and sexual desire for their partners and a decreased level of sexual desire for others during the ovulatory phase compared to the menstrual, the follicular, and the luteal phases.

Combined oral contraceptives (contain synthetic estrogen and progesterone) and progestin-only methods prevent ovulation and make cervical mucus thicker to inhibit sperm penetration (reviewed in Rivera, Yacobson, & Grimes, 1999). Therefore, common to all hypotheses, I make the following prediction.

5. Cycle changes in levels of the dimensions of heterosexual romantic relationships will not occur to contraceptive users as hormone changes mediating these effects are suppressed or altered by contraceptives.

Method

Participants

Participants were 57 heterosexual women who were students at Durham University (M_{age} = 21.42 years, *SD* = 4.54, 95% CI [20.22, 22.63]) and participated for payment and course credits. They were recruited through a participant pool in a psychology department or via social networking system outside the department. There were 40 naturally cycling women and 17 women on hormonal contraceptives such as combined oral contraceptives (Microgynon: *n* = 6, Yasmin: *n* = 3, Levest: *n* = 2, Femodene: *n* = 1, Loette: *n* = 1), and progestin-only oral contraceptives or implants (Cerazette: *n* = 2, Implanon: *n* = 2). Overall 5 naturally cycling woman were dropped from the analysis due to termination of the relationship during her participation (*n* = 1), using medication that affected her mood (*n* = 1), becoming ill during her participation (*n* = 1), and reporting irregular menses (*n* = 2). All participants (*N* = 52) had been in a committed romantic relationship, and relationship length ranged from 1.75 months to 16.54 years ($MD_{relationship\ length}$= 22.25 months, 95% CI [23.32, 48.69]). Their relationship status was 'Dating' (87%), 'Cohabiting' (6%), 'Engaged' (4%), and 'Married' (4%). The majority of women (94%) had a sexual relationship with their partners, 39% lived in the same city as their partners, and 96% were in contact (e.g., calling, meeting) with their partners every day. None of them was pregnant during the study, but one had children with her partner. Regarding ethnic backgrounds, 71% described themselves as European, 21% as Asian, 4% as North American, 2% as South American, and 2% as African.

Procedure

At an initial session the study was explained to participants. If they agreed to participate, they provided written informed consent and completed computer-based demographic and partner questionnaires. Naturally cycling women were also provided urinary ovulation test sticks (Clearblue® Easy Digital Ovulation Test) to detect LH surge. These women were given directions on how to use the tests and told what the test was measuring. After the initial session, all participants completed web-based daily questionnaires. Naturally cycling women answered the daily questionnaires from the first day of their menses until the first day of next menses. They also took the ovulation tests for a 10 day period during mid-cycle and reported the results (see below). Contraceptive users completed the daily questionnaires from the first day of a new package until the first day of the next package (Participants on implants started the daily questionnaires the day following the initial session and continued for 30 consecutive days). At debriefing sessions, all participants received £15 in vouchers and course credits.

Demographic and Partner Questionnaires

The demographic questionnaire asked participants' information on age, use of hormonal contraceptives, their menstrual cycles (i.e., the first date of previous period, usual cycle length, regularity of menses), primary partners, current relationships, and ethnic backgrounds.

The partner questionnaire measured male partners' attractiveness. Participants rated on visual analog scale (VAS: Folstein & Luria, 1973) on a computer screen by sliding a point within a single line between the left edge (0 = Not at all) and the right edge (100 = Very). Four items assessed the perceived attractiveness of their partner: *Physical Attractiveness* (''How physically attractive is your partner?); *Ambitiousness* (''How ambitious is your partner?); *Personality* (''How attractive is your partner's personality?''); and *Financial Prospects* (''How financially secure is your partner?''). Participants also rated overall level of commitment from and to their partners on VAS (''How committed is your partner to you?'' and ''How committed are you to your partner?''; between 0 = Not at committed and 100 = Very committed).

Daily Questionnaires

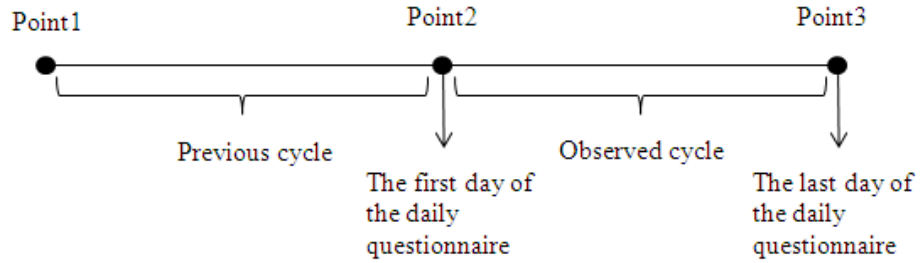
The daily questionnaire was composed of eight items. Six items were designed to assess the dimensions of pair-bond relationships. In order to keep the questionnaire short, one item was chosen from each cluster of items that loaded on the six factors (An item for attachment care-giving was taken from the original scale as the items loaded on the care-giving factor were all focusing on negative feelings. I could only choose one item for the current study; therefore, it was not preferable only focusing on a negative side of attachment.). The dimensions and corresponding items were as follows: *Obsession* (''My partner always seems to be on my mind.''); *Attachment care-receiving (''*I feel that my partner understand me when I have a hard time.''); *Attachment care-giving* (''I am prepared to be counted on by my partner and I will always be there for and care about my partner in times of need.''); *Attachment separation distress* (''I would feel despair if my partner left me.''); *Sexual desire for a partner* (''How strong is your desire to engage in sexual activity with your partner?''); and *Sexual desire for others* (''How strong is your desire to engage in sexual activity with a person you find attractive [not your partner]?''). Participants were instructed to think about their feelings toward partners (and others) that day and rated how true these six statements were in a 5-point scale (for obsession and attachment items: from 1 = Disagree strongly to 5 = Agree strongly; for sexual desire items: from 1 = No desire to 5 = Very strong desire). Participants also rated their mood (''How is your mood right now?'') on VAS (0 = Worst; 100 = Best). During the 10 day window in which they used the test sticks daily, they were also asked to report the result of their ovulation tests (as positive or negative)

A website was set up on which participants responded to the daily questionnaires. Participants notified us via emails when they started their menses (or a new pill package), then every subsequent morning they were emailed a link to the questionnaire. Participants were emailed daily in order to motivate them to complete the questionnaire every day. In addition, different links were sent to naturally cycling women during the ovulation tests intervals. The questionnaires continued until participants informed us of the onset of their next menses or the start of a new pill package. Participants were not able to see their previous responses and told not to go back to answer past questionnaires if they missed.

Naturally cycling women took the ovulation tests during their cycle. Ovulation is triggered by LH surge, and it is believed LH surge occurs 15 days prior to the onset of next menstruation regardless of one's cycle length (Asso, 1983). In order to schedule an ovulation test window tailored to each woman, I first estimated the first day of the next menstrual period based on her usual and previous cycle length (between Point1 and Point2 on Figure 1). This information on previous cycle length and the last menstrual onset (Point1) was reported in the initial session, and the date of subsequent menstruation onset (Point2) was emailed by the participant. After estimating the next menstrual onset (Point3), I estimated the date of impending ovulation (i.e., LH surge) by using the backward counting method. I asked women to use the ovulation test daily for a duration of ten days, beginning five days before the estimated LH surge day. I emailed individual schedules indicating when to use the ovulation tests to naturally cycling women on the first day of their participation. They were also reminded daily to take the ovulation tests on the scheduled days and to record their test results in the corresponding daily questionnaires.

Figure 1

Two Cycle Intervals



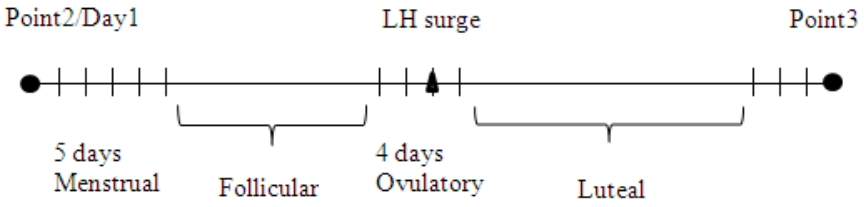
Note. Point1: The first day of menses before participation in the study. Point2: The first day of menses when participants started completing daily questionnaires. Point3: The first day of subsequent menses.

Menstrual Phase Coding

The cycle was divided into four phases based on findings of prior studies. A cross-cultural study (World Health Organization, 1981) showed that the mean length of menstruation is 4.7 days; hence, I coded five consecutive days from the onset of menses as the menstrual phase. Previous studies showed that the fertile-type mucus was most prevalent two days prior to the day of ovulation (Bigelow et al., 2004), and conception probability was highest during the three-day interval ending with the ovulation day (Wilcox, Weinberg, & Baird, 1995). The mature egg is released between 16 to 24 hours after LH surge, and the ovum has a maximal life span of 24 hours while sperm are viable for four to six days after ejaculation (reviewed in Silverthorn et al., 2007). Collectively, these data suggested that the ovulatory phase, when women are most fertile should be coded as four successive days (two days before and one day after the day of LH surge). With these milestones established, I identified the follicular phase as the time between the menstrual and the ovulatory phases, and the luteal phase is the interval between the ovulatory and the day three days prior the reported onset of the next menses. Hence, whereas the length of the menstrual and the ovulatory phases would be common with all participants, the length of the follicular and the luteal phases differed depending on individuals' cycle patterns (See Figure 2).

Figure 2

The Four Cycle Phases



For participants on hormonal contraceptives, the same system was applied. Although their ovulation was prevented by contraceptives, I took first five consecutive days to represent the menstrual phase. There were participants (n = 13) on a 28-pill packet (combined oral contraceptives), which contained 21 hormonally active tablets followed by a 7-day hormone-free interval to imitate a 28-day menstrual cycle. During this interval women normally experience menstrual bleed (Baerwald & Pierson, 2004). Thus for those participants, the start point of the cycle (Day 1) was set as the first day of the hormone-free interval. After the 5-day pseudo menstrual phase, two days before and one day after the pseudo LH surge day (estimated by the backward counting method) were taken to represent the ovulatory phase, the interval between the menstrual and the

ovulatory phases as the pseudo follicular phase, and the interval between the ovulatory and the day three days before Point3 as the pseudo luteal phase.

Statistical Analyses

Effects of cycle phase in four-phase classification. A mixed-design analysis of variance (ANOVA) was used to examine changes in scores on the dimensions of romantic relationships (*obsession*, *care-giving*, *care-receiving*, *separation*, *sexual desire for a partner*, and *sexual desire for others*) in relation to women's condition (*naturally cycling* and *hormonal contraceptives users*) as a between-subjects variable, with cycle phase (*menstrual*, *follicular*, *ovulatory*, and *luteal*) as a within-subjects variable. I summed and averaged each participant's scores on the daily questionnaires separately for each of six dependent variables for each cycle (or pseudo-cycle) phase.

Following the main analyses, perceived partner physical and investment attractiveness and mutual commitment variables were entered into a model as a between-subjects variable to analyse whether these variables moderated the relationship between cycle phase and the dimensions of heterosexual romantic relationships. Physical attractiveness ratings were those given in response to that specific item on the initial partner questionnaire. An investment attractiveness variable was created by summing scores on the personality, ambitiousness, and financial prospects items, in line with the previous research showing that kindness, understanding, ambitiousness, and financial prospects were women's most valued characteristics for long-term partners (Buss, 1989). A mutual commitment variable was created by summing commitment to and from partners. Then, I used a median-split to divide participants into lower and higher levels of physical attractiveness, investment attractiveness, and mutual commitment (n = 26 each), respectively. First, mixed-design 2 (condition) × 4 (cycle phase) repeated measures ANOVAs were conducted. Then, *physical attractiveness*, *investment attractiveness* and *mutual commitment* were included as a between-subjects variable in each analysis one at a time. As there were a large number of analyses, I will focus on reporting significant effects.

Effects of cycle phase in two-phase classification. Earlier it was noted that the variation in determining cycle phases might cause researchers to produce different conclusions for cycle phase effects (e.g., Harris, 2011). In order to investigate this point, I attempted to replicate the findings shown in Haselton and Gangestad (2006)'s study which hypothesized that partner desirability as a long- or short-term mate moderate cycle phase effect on sexual attraction. This study was chosen because the authors clearly explained how they divided a cycle and which statistical methods and variables used. To mimic their 'sexual versus investment attractiveness' variable ('sexual attractiveness' minus 'long-term attractiveness'), I subtracted financial security scores from physical

attractiveness scores. This variable was mean centered and used as a covariate. Next, I divided the present data into fertile and nonfertile phases based on their criteria in which a fertile phase was defined as ‘‘the day15 days prior to the first day of the next cycle (estimated day of ovulation) and the previous 4 days’’ and a non-fertile phase as ‘‘9 days: those between the estimated day of ovulation and 3 days prior to menstrual onset, excluding the 2 days immediately following ovulation’’ (p. 511). Using these two cycle phase variables as repeated factors, repeated measure ANOVA (with sexual versus investment attractiveness as covariate) on the six relationship variables were conducted.

Results

Menstrual Cycles

For naturally cycling women (n = 35), the observed mean cycle length during their participation (between Point2 and Point3; See Figure 1) was 30.83 days (SD = 4.05, MD= 30.0, 95% CI [29.44, 32.22]) ranging from 24 to 40 days. This observed mean cycle length was around 3.2 days longer than self-reported mean cycle length (SD = 3.34, MD= 28.0, 95% CI [26.51, 28.81]). Although 32 naturally cycling women experienced LH surge, three women showed no evidence of it. These women did not miss the urine tests during the scheduled period. This result might be due to a measurement error, anovulatory cycles (absence of ovulation), or an improperly scheduled test interval. The last possibility seems more likely as these women had a current cycle length six days longer or shorter than their previous cycle length. Thus, the ten days of scheduled test interval might have not included their LH surge timings. For these three women, I estimated LH surge date by counting 15 days back from the observed date of the next menstrual onset (Point3). Exclusion of these women did not make differences to results; thus, they were remained in analyses. For naturally cycling women, the mean interval between the LH surge date and the first day of subsequent menstruation among our participants was 15 days (SD = 2.67); however, the interval varied markedly from 9 to 21 days. In addition, two women experienced LH surge closer to the end of their cycles (6 and 8 days respectively before the next menstrual onset) and therefore had the unusually short luteal phase.

Table 1 displays each scale’s (obsession, care-receiving, care-giving, separation distress, sexual desire for a partner and others) means, standard deviations, and 95% confidence intervals for each of four phases and total means across phases for naturally cycling women and contraceptive users, respectively.

Table 1

Each Relationship Dimension Scale's Means, Standard Deviations, and 95% Confidence Intervals (CIs) for the Menstrual (M), Follicular (F), Ovulatory (O), and Luteal (L) Phases and Total Means Across Four Phases as a Function of Condition

		Naturally Cycling Women				Contraceptive Users			
Scale	Phase	*M*	*SD*	95% CI	M_{total}	*M*	*SD*	95% CI	M_{total}
Obsession	M	3.63	0.80	3.35, 3.90	3.66	3.94	0.60	3.63, 4.25	3.93
	F	3.63	0.82	3.35, 3.91		3.93	0.72	3.56, 4.31	
	O	3.76	0.86	3.47, 4.05		3.91	0.83	3.48, 4.33	
	L	3.61	0.94	3.28, 3.93		3.94	0.67	3.60, 4.29	
Care-Receiving	M	3.97	0.69	3.73, 4.20	3.83	4.15	0.85	3.71, 4.59	4.16
	F	3.77	0.73	3.52, 4.02		4.25	0.77	3.86, 4.65	
	O	3.81	0.80	3.53, 4.08		4.08	0.86	3.64, 4.53	
	L	3.75	0.69	3.52, 3.99		4.15	0.89	3.69, 4.61	
Care-Giving	M	4.43	0.50	4.25, 4.60	4.35	4.65	0.49	4.40, 4.91	4.64
	F	4.34	0.56	4.15, 4.53		4.69	0.36	4.51, 4.88	
	O	4.30	0.64	4.08, 4.52		4.57	0.44	4.35, 4.80	
	L	4.34	0.60	4.14, 4.55		4.62	0.40	4.42, 4.83	
Separation Distress	M	4.26	0.68	4.03, 4.49	4.16	4.52	0.44	4.29, 4.75	4.59
	F	4.12	0.87	3.82, 4.42		4.62	0.39	4.43, 4.82	
	O	4.13	0.95	3.80, 4.45		4.58	0.50	4.33, 4.84	
	L	4.12	0.97	3.79, 4.45		4.64	0.41	4.43, 4.85	
Sexual desire: partner	M	2.57	0.89	2.26, 2.87	2.83	3.09	0.99	2.58, 3.60	3.24
	F	2.87	0.69	2.63, 3.11		3.49	0.58	3.19, 3.79	
	O	3.09	1.11	2.71, 3.47		3.26	1.05	2.72, 3.80	
	L	2.80	0.87	2.50, 3.10		3.12	0.85	2.69, 3.56	
Sexual desire: others	M	1.34	0.51	1.17, 1.52	1.45	1.05	0.09	1.00, 1.09	1.12
	F	1.47	0.51	1.29, 1.64		1.17	0.28	1.02, 1.31	
	O	1.58	0.73	1.32, 1.83		1.19	0.31	1.03, 1.35	
	L	1.42	0.58	1.22, 1.61		1.09	0.10	1.04, 1.14	

Note. Naturally cycling women (n = 35) and contraceptive users (n = 17).

Effects of Cycle Phase in Four-Phase Classification

I first analysed whether the fertility status altered the six dimensions of heterosexual relationships in relation to the women's condition (naturally cycling women and hormonal contraceptives users) without considering the level of perceived partner attractiveness or mutual commitment. Table 2 shows that there was a significant main effect of condition (contraceptive use versus naturally cycling) on care-giving (F[1, 50] =

4.29, $p < .05$, $d = 0.61$), separation distress ($F[1, 50] = 4.37$, $p < .05$, $d = 0.62$), and sexual desire for others ($F[1, 50] = 7.62$, $p < .01$, $d = 0.77$). Table 1 shows that contraceptive users scored significantly higher on care-giving and separation distress than naturally cycling women, and naturally cycling women showed higher level of sexual desire for others relative to contraceptive users.

There was also a significant main cycle phase effect on sexual desire for a partner, $F(3, 150) = 3.24$, $p < .05$, $d = 0.51$, and a main cycle effect on sexual desire for others was approaching significance, $F(3, 150) = 2.47$, $p = .08$, $d = 0.44$. Although cycle phase effect was predicted to occur only for naturally cycling women, there was no interaction effect between cycle phase and condition. Regarding sexual desire for a partner (Figure 3), within-group phase comparisons using the ovulatory phase as the reference point showed that participants scored significantly higher desire at the ovulatory phase than at the menstrual, $t(51) = 2.50$, $p < .05$, $d = 0.70$, and the luteal phases, $t(51) = 2.10$, $p < .05$, $d = 0.62$, but the ovulatory phase was not significantly different from the follicular phase, $t(51) = 0.53$, $p = .60$, $d = 0.15$. Similarly, for sexual desire for others (Figure 4), women scored significantly higher desire at the ovulatory phase than at the menstrual, $t(51) = 2.22$, $p < .05$, $d = 0.62$, and the luteal phases, $t(51) = 2.00$, $p < .05$, $d = 0.56$, but the ovulatory phase was not significantly different from the follicular phase, $t(51) = 1.29$, $p = .20$, $d = 0.36$.

The finding of a main effect of cycle phase, with both hormonal contraceptive users and naturally cycling women showing the same shift on sexual desire at ovulation, was unexpected. This prompted consideration of factors other than the hormonal fluctuations associated with normal cycling that might affect sexual desire for partner and others. One possibility was mood. Although some studies have implicated hormonal shifts in mood changes (e.g., Parlee, 1982), mood may vary systematically over the cycle for other lifestyle reasons (e.g. freedom from concern about menstrual bleeding and discomfort). However there was no main effect of cycle on mood, $F(3,150) = 1.05$, $p = .37$, $d = 0.27$. This inability of mood changes to explain this effect was confirmed by introducing mood as a time-varying covariate in the original analysis. With mood controlled, sexual desire for partner remained significant, $F(3,148.93) = 3.42$, $p < .05$. Sexual desire for others also remained marginally significant as before, $F(3,149.51) = 2.45$, $p = .07$.

Table 2

Results of Mixed-Design Repeated Measures ANOVAs with Cycle Phase as a Within-Subjects Variable and Condition as Between-Subjects Variable

	Within effect		Between effect
	Cycle phase	Cycle × C	Condition (C)
Scale		*F*	
Obsession	0.17	0.43	1.70
Care-receiving	0.85	1.20	2.71
Care-giving	0.94	0.33	4.29*
Separation distress	0.10	1.48	4.37*
Sexual desire: partner	3.24*	1.12	3.87
Sexual desire: others	2.47^{+}	0.16	7.62**

Note. Condition: naturally cycling women (n = 35) and contraceptive users (n = 17).

* $p < .05$. ** $p < .01$. $^{+}p = .08$.

Figure 3

Mean Scores of Sexual Desire for a Partner (N = 51)

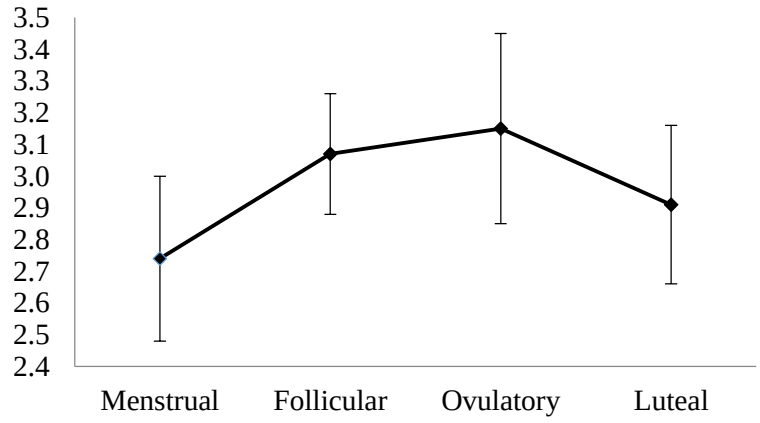
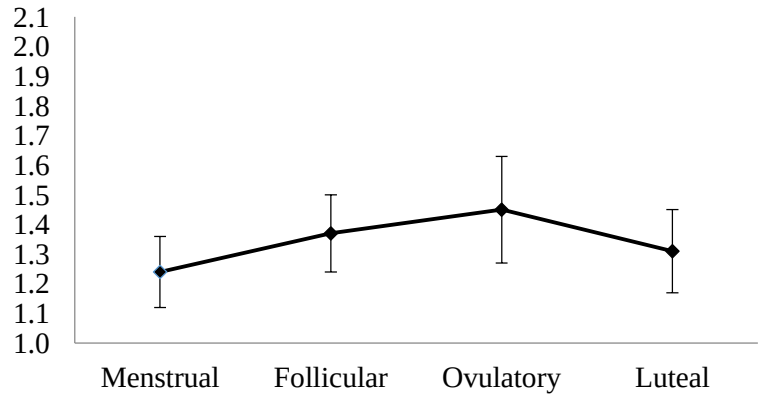


Figure 4

Mean Scores of Sexual Desire for Others (N = 51)



Partner Attractiveness and Mutual Commitment

A series of mixed-design repeated measures ANOVAs (described above) was run. This time perceived partner physical and investment attractiveness, and mutual commitment were entered as additional between-subjects variables (one at a time) in order to see if their inclusion affected the relationships between cycle phase and condition.-

Partner physical attractiveness. The results of mixed-design 2 (condition) × 2 (physical attractiveness) × 4 (cycle phase) ANOVAs are displayed in Table 3. According to the good genes hypothesis, it was expected that naturally cycling women partnered with less physically attractive men would show heightened sexual interest in other men and decreased emotional and sexual attraction towards their partners during the ovulatory phase than other phases. However, the results replicated the initial analysis and partner physical attractiveness showed neither a main effect nor any interaction with cycle phase across any of the dependent variables.

Table 3

Results of Mixed-Design Repeated Measures ANOVAs with Cycle Phase as a Within-Subjects Variable, and Condition and Physical Attractiveness as Between-Subjects Variables

	Within effect				Between effect	
	Cycle phase	Cycle×C	Cycle×P	Cycle×C×P	Condition (C)	Physical (P)
Scale	*F*					
Obsession	0.15	0.48	0.78	0.95	1.53	1.06
Care-Receiving	0.89	1.23	0.96	0.75	2.74	0.95
Care-Giving	0.97	0.34	0.77	0.36	4.04*	0.23
Separation distress	0.12	1.43	0.47	0.68	4.19*	0.002
Sexual desire: Partner	3.11*	1.10	0.20	0.17	3.87	0.02
Sexual desire: Others	2.37	0.17	0.36	0.52	7.32**	0.21

Note. Condition: naturally cycling women (n = 35) and contraceptive users (n = 17). Physical = Partner physical attractiveness. * $p < .05$. ** $p < .01$.

Partner investment attractiveness. The results of mixed-design 2 (condition) × 2 (investment attractiveness) × 4 (cycle phase) ANOVAs are displayed in Table 4. The good genes ovulatory shift hypothesis predicted that partner's investment attractiveness would not moderate the relations between the cycle phase and the relationship dimensions. In line with this prediction, partner investment attractiveness showed no interaction with cycle phase across any of the dependent variables. On the one hand, there were significant main effects of investment attractiveness on obsession, $F(1, 48) = 6.38$, $p < .05$, $d = 0.35$, and sexual desire for others, $F(1, 48) = 4.05$, $p < .05$, $d = 0.52$. Women who perceived their partners' investment attractiveness as higher scored greater on obsession and lower on sexual desire for others. The remainder of the results replicated the initial analysis.

Table 4

Results of Mixed-Design Repeated Measures ANOVAs with Cycle Phase as a Within-Subjects Variable and Condition and Investment Attractiveness as Between-Subjects Variables

	Within effect				Between effect	
	Cycle phase	Cycle×C	Cycle×I	Cycle×C×I	Condition (C)	Invest (I)
Scale	*F*					
Obsession	0.15	0.47	1.35	1.13	1.68	6.38*
Care-Receiving	0.86	1.27	0.83	1.39	2.55	3.63
Care-Giving	0.95	0.34	0.20	1.21	4.04*	3.57
Separation distress	0.10	1.44	0.97	0.98	4.11*	0.76
Sexual desire: Partner	3.23*	1.14	0.92	0.63	3.73	2.53
Sexual desire: Others	2.41	0.14	0.64	0.27	8.24**	4.05*

Note. Condition: naturally cycling women ($n = 35$) and contraceptive users ($n = 17$). Invest = Partner investment attractiveness. * $p < .05$. ** $p < .01$.

Mutual commitment. The results of mixed-design 2 (condition) × 2 (mutual commitment) × 4 (cycle phase) ANOVAs are displayed in Table 5. The attachment bond ovulatory shift hypothesis predicted that naturally cycling women with a higher level of mutual commitment would experience increased levels of emotional and sexual attraction towards their partners and a decreased level of sexual attraction towards other men during the ovulatory phase relative to other phases. However, mutual commitment did not show any interaction with cycle phase across any of the dependent variables. On the other hand, there were significant main effects of mutual commitment on obsession, $F(1, 48) = 6.82$, $p < .001$, $d = 0.74$, and on care-receiving, $F(1, 48) = 4.15$, $p < .05$, $d = 0.60$. Women with a higher level of mutual commitment scored higher on obsession and care-receiving than women with lower mutual commitment. A main effect of condition on care-giving, which was significant in the original analysis, was approaching significance ($p = .06$). The remainder of the results replicated the initial analysis.

Table 5

Results of Mixed-Design Repeated Measures ANOVAs with Cycle Phase as a Within-Subjects Variable and Condition and Mutual Commitment as Between-Subjects Variables

	Within effect				Between effect	
	Cycle phase	Cycle×C	Cycle×M	Cycle×C×M	Condition (C)	Mutual com (M)
Scale	*F*					
Obsession	0.16	0.43	0.51	0.15	1.10	6.82**
Care-receiving	0.91	0.93	0.97	0.14	1.86	4.15*
Care-giving	0.98	0.26	0.42	0.06	3.78^{+}	2.22
Separation distress	0.07	1.45	0.81	0.08	4.14*	3.44
Sexual desire: partner	2.88*	1.19	0.26	0.31	3.34	1.77
Sexual desire: others	2.26	0.17	0.29	0.78	7.34**	0.21

Note. Condition: naturally cycling women ($n = 35$) and contraceptive users ($n = 17$). Mutual com = Mutual commitment. * $p < .05$. ** $p < .01$. $^{+}p = .06$

Effects of Cycle Phase in Two-Phase Classification

Using a two-phase classification based on Haselton and Gangestad's criteria (2006), I analysed whether cycle phase altered the six dimensions of relationships depending on partner's physical versus investment attractiveness in naturally cycling women (n = 35). There was a significant interaction effect between cycle phase and partner attractiveness on sexual desire for others, $F(1, 33) = 5.41$, $p < .05$, $d = 0.21$, in which women whose primary partners were low in sexual attractiveness relative to their investment attractiveness showed greater sexual desire towards other men on 'fertile' days (M = 1.56, SD = 0.51,95%CI [1.30, 1.83]) than 'nonfertile' days (M = 1.35, SD = 0.48,95%CI [1.11, 1.60]), $t(16) = 2.08$, $p <. 05$, $d = 1.04$ (Interaction effects between cycle phase and the other dimensions were not significant). However, when the four-phase classification scheme used in the current analysis was applied, the significant interaction between cycle phase and physical versus investment attractiveness was not found, $F(3, 99) = 0.8$, $p = .45$, $d = 0.50$.

Discussion

The Good Genes and Attachment Bond Hypotheses

The present study attempted to test between these two explanations for cycle phase effect for women in a stable pair-bond relationship. The *good genes* ovulatory shift hypothesis proposes that cycle phase effect on fertile days functions to obtain genetic benefits either through a primary partner or extra-pair partner depending on a degree of partner physical attractiveness (Gangestad et al., 2005a; Haselton & Gangestad, 2006; Larson et al., 2013; Pillsworth & Haselton, 2006). The *attachment bond* ovulatory shift hypothesis proposes that, regardless of primary partner physical attractiveness, a strong attachment bond suppresses women's desire for extra-pair partners and increases intimate physical contacts with a primary partner on fertile days in order to protect and strengthen the pair-bond relationships (Eastwick & Finkel, 2012).

Results showed that there were a significant main effect of cycle phase on sexual desire for a partner and a marginally significant cycle phase effect on sexual desire for others. These findings are incompatible with the hypothesis that cycle phase effects would not occur in contraceptive users, as hormonal changes mediating these effects are altered by contraceptives (prediction 5). Within-group comparisons (using the ovulatory phase as the reference point) showed that cycle phase effect on two types of sexual desire followed a similar pattern, that is participants experienced higher sexual desire for a partner and others at the ovulatory phase than at the menstrual and at the luteal phases. However partner attractiveness and mutual commitment showed no significant interaction with the cycle phase on any of six relationship variables.

These findings did not support the good genes ovulatory shift hypothesis, which predicted that partner physical attractiveness would moderate the relationship between the cycle effect and the dimensions of romantic relationships for naturally cycling women (predictions 1 and 2). In addition, these findings did not support the attachment bond ovulatory shift hypothesis which predicted that attachment suppresses sexual attraction to extra-pair partners while enhancing sexual and emotional attraction towards primary partners. Contrary to the hypothesis (prediction 4), an increase in sexual desire for a partner was not altered by level of mutual commitment, and there was also a rise in sexual desire for others at the ovulatory phase.

A General Increase in Sexual Desire?

Previous studies have attributed the cycle phase effect to hormonal fluctuations across a menstrual cycle, especially around the time of ovulation (e.g., Roney & Simmons, 2008). In the current study, cycle phase effects were found on sexual desire enhancing women's sexual attraction towards both primary partners and extra-pair men near ovulation. These findings suggest the possibility of a non-specific increase in sexual desire during fertile days (Roney, 2009). This view is consistent with others who claimed that females evolved to experience greater sexual desire on fertile days to increase conception probability (Riley, Riley, & Brown, 1986; Wallen, Winston, Gaventa, Davisdasilva, & Collins, 1984). Indeed, estradiol, which is known to increase around the ovulation, has been examined as contributing to women's sexuality (Roney & Simmons, 2013). Although there is no uniform agreement about which hormones are mainly associated with sexual desire, previous studies showed positive relationships between female sexual desire and estradiol (Roney & Simmons, 2013; Wallen et al., 1984).

If fluctuations in female gonadal hormones and women's sexual desire are positively associated, hormonal contraceptive users are expected to experience this ovulatory shift effect differently from naturally cycling women as contraceptives will inhibit ovulation (Roberts, Cobey, Klapilová, & Havlíček, 2013). Indeed, Gangestad and Thornhill (1998) showed that the cycle phase effect found in naturally cycling women was absent in hormonal contraceptive users. However, in the current study, there was no difference between naturally cycling women and contraceptive users in the cycle phase effect on their sexual desire. Below, I examine possible explanations for this unexpected result.

One is that contraceptive users did experience the fluctuations in female gonadal hormones to some degree. In fact, progestin-only oral-contraceptives and implants do not suppress ovulation completely, and studies showed that the ovulation occurs frequently for women on progestin-only methods (reviewed in Rivera et al., 1999). Furthermore, women on combined oral contraceptives with low ethinylestradiol (EE) dose (below 30

microgram: see Baerwald & Pierson, 2004) were also shown to experience a rise in FSH and LH and follicle development during a hormone free interval (e.g., Rible, Taylor, Wilson, Stanczyk, & Mishell, 2009). In the present study, 13 participants were on combined oral contraceptive with EE concentration between 30 and 20 microgram, and 4 participants were on progestin-only methods. This raises the possibility that women in the present study may have experienced hormonal fluctuations to some extent, resulting in an increase in sexual desire during the pseudo ovulatory phase.

A second possibility is that testosterone may prompt the increase in sexual interest. Some studies have shown a rise in testosterone prior to and during ovulation in normally cycling women (Campbell & Ellison, 1992; also reviewed in van Anders, Goldey, & Bell, 2014). However, despite the popular belief that testosterone enhances sexual desire in women, firm empirical support from human studies is scant (van Anders, 2012). Furthermore, the effect of hormonal contraceptive use on testosterone levels is unclear: It appears to decrease testosterone levels in some but not all women (van Anders, 2012). Nor is it clear whether contraceptive users experience alterations in testosterone levels at key phases during their 'pseudo' cycles. Further research on this possibility would be worthwhile.

A third possibility is that factors other than hormonal changes have an influence on women's sexual desire throughout the cycle. Mood was examined as a plausible candidate, but it failed to mediate changes in women's sexual desire. Other factors require examination, including the possibility that women's sexual desire is responsive to a greater sense of freedom and autonomy when menstruation is not seen as an obstacle to sexual activity. Indeed, the current data showed that sexual desire was particularly low during the menstrual phase. A fourth possibility is a 'carry over' effect. If increased levels of sexual desire are experienced during ovulation by naturally cycling women prior to beginning hormonal contraceptive use, these effects may become habitual even without the hormonal infrastructure that initially supported them. Finally, the possibility of demand characteristics cannot be excluded: The popular press and web sites communicate findings from evolutionary psychology and participants may have been aware that sexual desire was expected to alter during the cycle. A month-long repeated-measures design of this kind almost inevitably alerts participants to its focus on the menstrual cycle and media information may have cued them to expect changes in sexual desire. This may have been equally true for contraceptive users as for naturally cycling women.

The fact that sexual desire toward both partners and others (in both groups of women) increased at ovulation also requires explanation. Sexual desire toward a partner showed a stronger effect of cycle, suggesting that women may focus their sexual attention more strongly towards their partners as Fisher (1998) hypothesized, with sexual desire for others being a 'spill-over' effect from partner-directed desire. This opens up a broader

question about the fundamental targeting of women's sexual desire. Fisher (1998) argued that romantic feelings lead individuals to focus their sexual attraction towards a particular partner; however, a response to sexual stimuli from other men might not be suppressed completely at the desire level. Women may experience a general enhancement of sexual desire which is normally directed toward the partner (via inhibition of desire to others) and the rise in sexual desire for others may reflect a relaxation of those inhibitory constraints. This disinhibition may be a function of partner attractiveness as found by Haselton and Gangestad (2006), although the current data suggest that the effect may not depend on naturally-occurring hormonal changes. In future studies, sexual desire for both partners and others should continue to be investigated. Some prior studies have questioned participants about only one or the other (Haselton & Gangestad, 2006; Eastwick & Finkel, 2012), precluding the possibility of examining hormonal effects on a general increase in sexual desire.

The Effect of Hormonal Contraceptives

There were differences between naturally cycling women and contraceptive users in overall scores on three relationship dimensions. Contraceptive users experienced greater care-giving and separation distress and lower sexual desire for others than naturally cycling women. This might be due to potential psychological side-effects introduced by the contraceptive use. Some researchers suggested that ethinylestradiol in hormonal contraceptives affects emotional and sexual attention within pair-bond relationships, leading to differences in relationship quality between contraceptive users and naturally cycling women (Cobey, Pollet, Roberts, & Buunk, 2011; Geary, DeSoto, Hoard, Sheldon, & Cooper, 2001). Studies showed that contraceptive users, compared to naturally cycling women, reported greater intensity of jealousy (Geary et al., 2001) , and more frequent mate retention behaviours towards their partners (Welling, Puts, Roberts, Little, & Burriss, 2012). This may imply that contraceptive users in the present study, compared to naturally cycling women, were also engaging in more mate retention behaviours directed towards their partners, which might have been reflected in higher separation anxiety and care-giving to partners and less sexual attention towards other men. However, it is still unclear why there was no difference in sexual desire for a partner (and other emotional dimensions) between the two groups. Further research on how hormonal contraceptive use alters emotional and sexual attention towards partners and others is required.

Measurement Issues

Research on cycle phase effects is unlikely to produce coherent and reliable results unless measurement issues are addressed. Indeed, researchers have pointed out

that measurement disparities could produce different conclusions within the same data set (e.g., Regan, 1996). For example, Harris (2011) attempted to replicate Penton-Voak et al. (1999)'s finding that women in a fertile phase prefer more masculine faces than women in a nonfertile phase. She used several different counting methods to categorize female participants into either a fertile or nonfertile phase according to women's self-reported information about their menstrual cycle. For example, Penton-Voak and Perrett (2000) defined a fertile phase as days 6-14 since the last menstrual onset and a nonfertile phase as day 0-5 (the menstrual phase) and 15-28 in a 28-day cycle. Using this system, Harris found that in her sample 80 women were in a fertile phase while 168 were in a nonfertile phase. Based on this classification and contrary to Penton-Voak et al.'s finding, women in a fertile phase preferred less masculine faces than women in a nonfertile phase. She also used Macrae, Alnwick, Milne, and Schloerscheidt's (2002) classification in which a fertile phase was defined as a 3-day interval ending with the estimated ovulation day and a nonfertile phase as the first three days of the menstrual phase. Using this system, 33 women were in a fertile phase while 207 were in a nonfertile phase, and the analysis showed no significant effect of phase on facial masculinity. These inconsistent findings raise questions about the reliability (and the diversity) of counting methods.

I attempted to replicate Haselton and Gangestad's study (2006) by following their two-phase classification which was also based on the counting method. When I divided the current data into fertile or nonfertile phases according to their criteria, I succeeded in replicating their finding: Women whose partners were low in sexual attractiveness relative to investment attractiveness showed greater sexual desire towards other men on 'fertile' days than 'nonfertile' days. However, when I used four-phase classification based on my criteria, there was no such effect.

It might be useful to consider what is contributing to these contrary findings in cycle phase effect studies. First, I checked how observed ovulation timings in the present data would be defined by Haselton and Gangestad's criteria. In the present study, 32 naturally cycling women detected the LH surge using urinary tests. When I divided observed cycles in the current data into fertile and nonfertile phases based on their criteria, 14 out of 32 ovulation points detected by LH surge would have been categorized by their criteria as 'non-fertile'. This implies that, in previous studies using the counting methods, there is likely to be a considerable amount of noise in the data leading to unreliable findings.

Moreover, using the present data of naturally cycling women, I re-calculated the ovulation timing by using the backward counting method in each observed cycle. The ovulation days estimated by the backward counting method were spread over three phases (based on my criteria): 9 were at the follicular phase; 18 were in the ovulatory phase; and 5 were at the luteal phase. Although 56% of the estimated ovulation days were accurately

identified, 44% were outside the actual ovulatory phase. On the other hand, in the current study there was no significant difference between the ovulatory and the follicular phases, implying that the change in sexual desire intensity showed the same effects in these two phases. This finding has important implications suggesting that it might be adequate to merge the ovulatory into the follicular phases. However, the backward counting method introduces noise, and some studies generally considered cycle phase effect being due to 'high fertility' despite using 'fertile phase' composed of the ovulatory phase and the follicular phase (e.g., Penton-Voak & Perrett, 2000). Strictly speaking, one should limit 'fertile' phase to the ovulatory phase when examining the link between cycle phase effect and fertility.

Furthermore, in previous studies the ovulation timing was often estimated based on the 'predicted' onset of next menstruation (e.g., Macrae et al., 2002). However, self-reported cycle length often deviates (shorter or longer) from observed cycle length (e.g., Jukic et al., 2008; Sheldrake & Cormack, 1976). Indeed, in the current study the observed mean cycle length was around three days longer than self-reported mean cycle length. These findings indicate that women may not always be able to accurately estimate their cycle length and the next menstrual onset. Hence using the backward counting method based on the predicted next menstrual onset might be a serious problem by generating artefactual findings, as others have pointed out (e.g., Jukic et al., 2008).

Strength and Limitations

The issues of fertility estimation methods in previous studies underline the importance of assessing ovulation timing with more reliable method in order to examine cycle phase effect in a more accurate manner. In the current case, the LH surge date was detected by urinary test, which allowed the fertile window to be based on a reliable index. Furthermore, the current study improved the quality of data by examining a wider range of relationship-relevant dimensions for a complete menstrual cycle (from the menstrual onset to the next menstrual onset). It also included a control group of contraceptive users. Based on the assumption that changes in partner preference are due to hormonal changes over a menstrual cycle, most previous studies have recruited only naturally cycling women. Yet the inclusion of hormonal contraceptive users in this study was important in showing that a 'cycle' effect on sexual desire can also be found in contraceptive users and hence may not be a function of fluctuating hormones. To firmly demonstrate alleged hormonal effects, future studies should collect daily saliva assays to monitor hormone levels (including testosterone).

The current study has several limitations that might be addressed in future work. First, I used perceived physical or investment attractiveness of primary partners rather than more objective measures of actual fluctuating asymmetry or financial income. It is

likely that participants' ratings were influenced by a woman's feelings towards her primary partner. However, it is a women's perception of her partners' attractiveness that is most likely to mediate the ovulatory shift effect: External stimuli affecting mating strategy must be filtered through subjective perceptions and appraisals. Second, attractiveness of extra-pair partners was not examined in the current study. Therefore, it is uncertain that whether these extra-pair partners were viewed as attractive in the context of potential long-term or short-term relationships. Third, in order to make daily questionnaire as brief as possible, I asked for ratings on one item each for six dimensions of heterosexual relationships, therefore possibly decreasing the reliability of the measurement.

Conclusion

The present study examined two contrasting hypotheses about menstrual cycle effect on mate preferences: the good genes ovulatory shift hypothesis and the attachment bond ovulatory shift hypothesis. Results showed that cycle phase effects were evident for sexual desire for both a partner and others, and hence did not support either hypothesis. Methodological issues in the field of cycle effect studies were identified, and it was noted that it is critical to use more reliable method to identify the ovulation timing and hormonal levels if the cycle phase effect is to be tested adequately. The inconsistency findings in this field might be largely due to this methodological problem. The present study suggests that women's fluctuating sexual desire might be influenced by factors other than hormonal changes.

Chapter Seven
General Discussion

Romantic love, sexual desire, and adult attachment mechanisms were proposed to be evolved adaptations which initiate, build, and maintain a pair-bond relationship with a selected partner (Buss, 2006; Fisher, 1998; Frank, 1988; Hirshleifer, 1987). Fisher (1998) hypothesized that 'sexual desire' drives one to seek sexual union with members of the opposite sex, 'romantic love' leads one to direct preference to a specific sexual partner, and 'adult attachment' functions to maintain a pair-bond relationship long enough for successful child rearing. Based on their hypothesis, this thesis focused on a human pair-bond relationship, which was defined as '*a bond with a preferred individual that is initiated and maintained by sexual desire, romantic love, and attachment mechanisms*'. Studies were conducted to explore the functions of the pair-bond mechanisms (i.e., sexual desire, romantic love, and adult attachment) and to test whether these mechanisms differed as a function of sex, culture, age, and relationship variables (e.g., relationship stage, personality, and conception probability).

Conceptual Frameworks of the Thesis

Throughout the thesis, life history theory (reviewed in Kaplan & Gangestad, 2005) was used as a main conceptual framework. The theory assumes that organisms allocate resources (e.g., energy, time, and money) to different life history tasks (e.g., growth, reproduction). Decisions regarding the resource allocation involve trade-offs between life history tasks, because the available resources and lifespan are limited. Among these trade-offs, the thesis focused on a trade-off between mating effort and parental effort. Mating effort is associated with the resource allocation to obtain sexual partners while parental effort is related to the resource allocation for reproduction and child rearing (Low, 1978). In order to maximize fitness in light of the current environment and individual differences (e.g., sex, relationship status), a 'decision' (conscious or unconscious) is needed about how to allocate resources to mating and parenting. Thus, although the pair-bond relationship mechanisms may be universal adaptations, the expression of these mechanisms may have different settings as a function of sex, culture, and individual differences (Penke, 2010; Tooby & Cosmides, 1990).

Pair-Bond Relationship Dimensions

Based on the life-history perspective, the pair-bond relationship mechanisms (romantic love, sexual desire, and adult attachment) were conceptually integrated with the trade-off between mating effort and parental effort. Adult attachment was defined as '*an affectional bond between two individuals maintained through mutual care-receiving and*

care-giving behaviours, involving separation distress and proximity seeking behaviours'. Fisher (1998) hypothesized that attachment functions to maintain pair-bond relationships for successful child rearing and thus adult attachment was viewed as being associated with parental effort. Sexual desire was defined as 'sexual desire' as '*an internal state of willingness or motivation to have sexual intercourse with an individual to whom one is sexually attracted*'. According to Fisher (1998), one can have sexual desire towards members of the opposite sex while romantic love leads one to focus on a certain mating partner. Informed by this hypothesis, sexual desire was divided into sexual desire for a particular person with whom one is in love, and sexual desire for others apart from this individual. Corresponding to this distinction, mating effort was divided into a pair-bond relationships context and a short-term (i.e., uncommitted) relationship context. Thus, partner-directed sexual desire was expected to be associated with pair-bond mating effort and other-directed sexual desire with short-term mating effort. Romantic love was defined as '*an intense desire for emotional union with and possessive feelings towards a particular individual*'. Fisher's hypothesis (1998) suggested that romantic love is the emotional side of partner-directed sexual desire. If this is the case, romantic love is also expected to be associated with pair-bond mating effort.

Sex Differences

Life history theory implies that individuals in different circumstances and subject to different constraints should deal with the trade-off between mating and parenting efforts differently, and this may be reflected in the intensity of pair-bond relationship dimensions. Individuals can differ at many levels, but sex differences were one of the most important sub-themes in the thesis. It has been argued that females are generally choosier about mates and allocate more to parental effort than males, while males are more competitive and allocate more to mating effort than females (Darwin, 1871). This conventional sex role view was proposed to result from the asymmetry in minimal reproductive costs before and after the birth of offspring with females investing more than males (Bateman, 1948; Trivers, 1972). The conventional sex role perspective assumes that lower minimal reproductive cost for males allow them to enhance their reproductive success by mating with many females. On the other hand, higher minimal reproductive cost for females leads them to invest more parental care in the current offspring. This suggested that males are expected to show greater sexual desire for a partner and also for others (i.e., mating effort) than females, whereas females are expected to show greater partner attachment (i.e., parenting effort) than males. However, recent theoretical developments have proposed that sex roles may not be so easily classifiable as the traditional models assumed, and that other factors such as reproductive environments, sex-specific breeding costs, mortality cost, and mate qualities (Gangestad & Simpson,

2000; Kokko & Monaghan, 2001) may also be significant parameters determining sex role divergence. Although it is important to understand the role of these factors, it was not easy to identify and measure every possible factor that might cause sex role divergence in humans. Instead, the thesis sought to test sex differences in the pair-bond relationship dimensions from a broad conventional sex role view (higher sexual desire and lower attachment for males than females), and to explore how sex roles diverged within the sample studied. Sex differences were addressed in Chapter Four and Chapter Five.

Long-Term and Short-Term Mating Strategies

Fisher's hypothesis (1998) indicates that humans have evolved pair-bond mechanisms to form and maintain long-term relationships. Sexual strategies theory (Buss & Schmitt, 1993) proposes that humans (both men and women) have evolved distinct long- and short-term mating strategies that address different reproductive problems. For example, one might pursue a long-term mating strategy to obtain extended provision of resources and parental care for offspring or pursue a short-term mating strategy to increase access to a number of fertile sexual partners. However, the theory also proposes that there are costs associated with both long- and short-term mating strategies. For instance, one may lose heavy investment due to a poor long-term mate choice, and frequent extra-pair sexual intercourse may increase the risk of contracting sexually transmitted diseases. Therefore, evolutionary theory predicts that individuals should weigh the costs and benefits of strategies (again, not necessarily consciously) and select the strategy that shows the greatest net utility. This implies that individual circumstances (e.g., one's own mate value, operational sex ratio in a population, and cultural norms) have a substantial influence on decisions about mating strategies (Buss & Schmitt, 1993; Buss, 2002). However, critics have pointed out that the theory lacks clear definitions of relevant concepts and the important components of human pair-bond relationships. First, the definitional distinction between long- and short-term mating strategies is unclear, because individuals differ in their perception of the duration of and distinction between short- and long-term relationships (Eastwick, 2009). Second, the associations between emotional components and mating strategies were not addressed by the theory (Smiler, 2011). In order to use sexual strategies theory as a research framework, the thesis used the term 'long-term' to refer to pair-bond relationships (involving emotional and physical attraction, but not defined by relationship length), and 'short-term' to refer to any form of uncommitted sexual relationship. Thus, partner-directed romantic love, attachment, and sexual desire components were expected to be associated with a long-term mating strategy, while other-directed sexual desire was expected to be associated with a short-term mating strategy.

Preferences for long- versus short-term mating strategies are associated with context (Smiler, 2011). For example, as discussed above, a conventional sex role perspective assumes that men may place more emphasis on short- than on long-term strategies, while females may be more prone to emphasize long- than short-term strategies. Nevertheless, considerable within-sex variability in mating strategic decisions is expected. Focusing on female mating strategies, it was suggested that females have evolved to experience stronger sexual desire when their conception probability is highest (i.e., near ovulation) and women during this phase will become selective about their sexual partners (Gangestad & Thornhill, 1998). There are two different hypotheses regarding the effect of cycle phase on mating strategies. The good genes hypothesis argues that the cycle phase effect functions to gain genetic benefits for offspring either through primary partners or extra-pair partners depending on the woman's primary partner's physical attractiveness (Gangestad et al., 2005a; Haselton & Gangestad, 2006; Larson et al., 2013; Pillsworth & Haselton, 2006). The hypothesis predicts that women paired with more physically attractive men will experience greater partner-oriented romantic love, attachment, and sexual desire together with lower sexual desire towards others during the ovulatory phase. Women paired with less physically attractive men will experience a reduction in all partner-directed components together with higher other-directed sexual desire near ovulation. By contrast, the attachment bond hypothesis proposes that cycle phase effect functions to suppress attraction towards extra-pair partners and so protect the current pair-bond regardless of primary partners' physical attractiveness (Eastwick & Finkel, 2012). The hypothesis assumes that women's higher level of long-term relationship commitment may enhance the levels of partner-directed romantic love, attachment, and sexual desire components and decrease the level of sexual desire towards others during the ovulatory phase. These two hypotheses were tested in Chapter Six.

Personality dimensions may also mediate strategic mating decisions (Rushton, 2008). One such personality trait is the General Factor of Personality (GFP; Musek, 2007) which is derived from the five personality traits of *Extraversion*, *Agreeableness*, *Conscientiousness*, *Emotional stability*, and *Openness* (Costa & McCrae, 1992a; Digman, 1990). GFP was proposed to be associated with long-term mating strategies (i.e., more stable pair-bonds and greater parental care) (Rushton, 2008), implying it would positively predict partner-oriented romantic love, attachment, and sexual desire and negatively predict other-directed sexual desire. Another personality trait which may mediate mating strategic decisions is Dark Triad (DT), which is a constellation of the three personality traits of *Machiavellianism*, *Psychopathy*, and *Narcissism* (Paulhus & Williams, 2002). Contrary to GFP, DT was proposed to be associated with short-term mating strategies (e.g., more open to casual sex, more uncommitted relationships) (Jonason, Li, et al.,

2013; Jonason et al., 2009). Therefore, it was expected that DT would be negatively predict partner-oriented romantic love, attachment, and sexual desire and positively predict other- directed sexual desire. The effects of personality traits on the relationship dimensions were addressed in Chapter Five.

Although the effects of sex, menstrual cycle, and personality traits on one's mating strategies are proposed to be evolved adaptations, cultural factors are another avenue for exploration. Two of Hosftede's (1980) cultural dimensions, *individualism-collectivism* and *masculinity-femininity*, can be applied to understand how culture may influence individuals' broad tendencies to prefer long- or short-term mating strategies. The individualism-collectivism dimension focuses on conceptions of individuality. In individualistic societies, individuals value independence and autonomy, whereas in collectivist societies one's sense of self is embedded in the surrounding social and relational context (Markus & Kitayama, 1991). In collectivist societies, intimacy is diffused across in-group members due to the strong connectedness among them, resulting in decreased intimacy towards one particular person, including romantic partners (Dion & Dion, 1988). The masculinity-femininity dimension focuses on the extent to which a society is characterised by more masculine versus feminine qualities (Hofstede, 1980, 1998). In masculine societies, men are expected to be more 'masculine' (e.g., assertive) while women are expected to be more 'feminine' (e.g., value pair-bond relationships and parenthood). In feminine societies, these sex differences are expected to be smaller. These characteristics of individualist-collectivist societies and masculine-feminine societies imply that in more collectivist and masculine societies, compared to more individualist and feminine societies, partner-oriented components (romantic love, sexual desire, attachment) will be less intense and the magnitude of expected sex differences in the relationship dimensions (i.e., higher sexual desire in men and higher attachment in women) will be greater. The thesis compared Japan (as a more collectivist and masculine society) and Occidental countries (as more individualist and feminine societies) in order to examine effect of culture on the pair-bond relationship dimensions (Chapter Four).

A Summary of the Thesis

In order to test predictions, items were selected and/or modified from existing measurements for each of the four pair-bond relationship dimension (Chapter Two). Some of these items were used to assess whether individuals differed in the intensity of these relationship dimensions as a function of personality (Chapter Five) and female conception probability (Chapter Six). Moreover, a series of factor analyses was conducted separately for the Japanese and Occidental groups to identify common dimensions of pair-bond relationships for both groups (Chapter Three). The resulting six factors were sexual desire related dimensions (sexual desire for a partner and others), a

romantic love related dimension (obsession), and attachment related dimensions (care-receiving, care-giving, separation distress). Items loading on the six factors for both cultural groups each were used to construct common self-report measurements. These scales were used in the subsequent study (Chapter Four) which examined whether the intensity of the six relationship dimensions differed as a function of age, relationship status, sex, and cultural background (Japan versus Occidental countries). This final chapter provides a synthesis of the findings on the effects of sex, temporal variables (age and relationship stage), culture, personality traits, and menstrual cycle on the pair-bond relationship dimensions. The extent to which these findings converge to support the evolutionary perspective on pair-bond relationships is discussed. Note that the sample used in Chapter Four the samples were Japanese and Occidental (mainly British and other European) men and women, in Chapter Five was composed of British men and women, and in Chapter Six young (mainly British) women.

The Main Effect of Sex

Sexual desire. Following the conventional sex role perspective, it was predicted that men would show stronger sexual desire (both for a partner and others) than women. As expected, there were medium to large effect sizes of respondent sex on sexual desire for a partner and others. Men scored higher than women on both partner-directed and other-directed sexual desire, but with a much stronger effect for other-directed desire. This supports the conventional sex role perspective which predicts men's higher sexual desire, especially for extra-pair partners. However, this sex difference in partner-directed sexual desire showed different patterns across age and cultural groups (see 'The Interaction Effect between Sex and Age' and 'The Interaction Effect between Sex and Culture' below).

Attachment. Because the conventional sex role perspective assumes that women allocate more to parental effort than men do, it was predicted that women would show greater partner-oriented attachment. However, across the studies, sex did not influence the intensity of adult attachment (care-receiving, care-giving, separation distress in Chapter Four and attachment in Chapter Five) as either a main effect or in interaction with other variable. This suggests that adult attachment systems operate with equal strength in both sexes.

The Main Effect of Age

Sexual desire. It was predicted that mating effort (measured as sexual desire for a partner and others in the present study) would be a higher priority in younger than older individuals, because age is inversely associated with fertility for both men and women (Balasch, 2010; Dunson et al., 2004; Hassan & Killick, 2003; Kovac et al., 2013; Wallace

& Kelsey, 2010). Contrary to this prediction, there was a small main effect of respondent age on sexual desire for a partner and others, with the youngest age ('16-21' year-old') group reporting lower desire than the oldest age ('35+ year-old') group. However, the effect of age on sexual desire for a partner showed different patterns across sexes (see 'The Interaction Effect between Sex and Age').

The Main Effect of Relationship Stage

Attachment. The trade-off between mating and parental effort may vary during the course of a relationship. It was predicted that at more serious relationship stages (engaged, cohabiting, married) individuals might focus more on preparing for parental effort (i.e., adult attachment) than at less committed relationship stages (one-sided love, dating). Fisher (1998) argued that attachment functions to strengthen the pair-bond to complete child rearing, thus implying that attachment would become stronger after having children. There was a significant main effect of relationship stage on all attachment dimensions (care-receiving, care-giving, separation distress), in which attachment was greater in mutually committed relationships (dating, engaged, cohabiting, married) than in one-sided love relationships. However, contrary to Fisher's hypothesis, parenthood did not affect the intensity of attachment.

The Main Effect of Culture

Sexual desire. Partner-directed sexual desire was expected to be less intense in Japan than in Occidental countries due to the cultural characteristics of collectivism in Japan (i.e., diffused intimacy between other social members) and masculinity in Japan (i.e., less focused attention on relationships) (Dion & Dion, 1988; Hofstede, 1998; Markus & Kitayama, 1991). As expected, Japanese scored significantly lower than Occidentals for partner-directed sexual desire. Japanese also scored significantly higher than Occidentals for other-directed sexual desire. However, these cultural differences in sexual desire showed different patterns across sexes (see 'The Interaction Effect between Sex and Culture' below).

Romantic love/Obsession. In more collectivist societies, intimacy might be diffused across the in-group, and in more masculine societies pair-bond relationships may be less valued than in more feminine societies (Dion & Dion, 1988; Hofstede, 1998; Markus & Kitayama, 1991). In support of this, there was a large main effect of culture, in which the Occidental group showed a significantly higher level of romantic love (i.e., obsession) than the Japanese group. If romantic love is a psychological component of pair-bond mating effort and therefore related to long-term reproductive strategy, this finding suggested the importance of cultural factors in determining the degree of sex role divergence.

Attachment. In more collectivist societies intimacy can be diffused between other social members, and in more feminine societies one may value parenthood more than in masculine societies (Dion & Dion, 1988; Hofstede, 1998; Markus &Kitayama, 1991). As expected, there was a small to medium main effect of culture on attachment (care-receiving, care-giving, separation distress), in which the Occidental group reported greater levels of the attachment than the Japanese group. However, this cultural differences in care-receiving and care-giving showed different patterns across age groups (see 'The Interaction Effect between Culture and Age' below).

The Main Effect of Personality Traits

Sexual desire. The general factor of personality (GFP) was expected to be positively associated with long-term mating strategies. Hence, it should be positively correlated with partner-directed desire and negatively correlated with other-directed sexual desire. The Dark Triad (DT) was hypothesised to have the opposite effect. The findings supported these hypotheses. This implies that GFP supports long-term mating strategies, while DT facilitates short-term mating strategies. However, the lack of a significant negative correlation between GFP and DT showed that they are orthogonal traits. Therefore, long- and short-term mating strategies may not be mutually exclusive alternatives (Buss & Schmitt, 1993). This suggests that one can possess both personality traits, which jointly affect individuals' strategic mating decisions. Furthermore, the conventional sex role perspective has been used to argue that DT forms the psychological infrastructure of 'male' mating strategies (Jonason, Webster, & Schmitt, 2009) whereas GFP might constitute the psychological basis of female mating strategies. However, these correlations between personality traits and sexual desire did not differ for men and women. This suggests that individual differences in mating patterns associated with sex and personality traits are unrelated to each other.

Romantic love/Obsession. GFP was expected to facilitate long-term mating strategies and hence positively predict romantic love. DT was expected to facilitate short-term mating strategies and thus negatively predict romantic love. The results showed that GFP indeed positively predicted romantic love, but DT was not significantly associated with romantic love. Again, this finding may imply that GFP supports long-term mating strategies. As with the associations between personality traits and sexual desire, sex did not moderate the association between GFP and romantic love. This again did not support the view that GFP might constitute the psychological base of 'female' reproductive strategies.

Attachment. GFP was expected to be positively associated with adult attachment while DT was expected to show a negative association. These hypotheses were supported. Again, this finding may imply that GFP supports long-term mating

strategies while DT does not. As with the associations between personality and other relationship dimensions (sexual desire, romantic love), sex did not moderate the association between either of the personality traits and adult attachment. This again did not support the conventional sex role perspective which implies that GFP might mediate female reproductive strategies while DT mediates male mating strategies.

The Main Effect of Menstrual Cycle Phase

Sexual desire. The good genes hypothesis predicts that, during fertile days, partners' physical attractiveness is positively associated with partner-directed sexual desire and negatively with other-directed sexual desire. On the other hand, the attachment bond hypothesis predicts that women's higher level of relationship commitment increases partner-directed sexual desire and decreases other-directed sexual desire during fertile days. There was a medium-sized main effect of cycle phase on both partner- and other-directed sexual desire (for both naturally cycling women and contraceptive users), in which women reported increased desire during the ovulatory phase compared to during the menstrual and the luteal phases. Contrary to the two hypotheses, these effects were not altered by the levels of partner physical attractiveness or mutual commitment. One important possibility arising from this finding is that women may feel stronger sexual desire when conception probability is highest, but this shift may not occur selectively towards particular men. This supports Roney's (2009) suggestion of a non-specific increase in sexual desire days around ovulation. Nonetheless, the fact that the same pattern was found for pill-users raises doubts about the hormonal basis of this fluctuation. On the other hand, mean scores for partner-directed sexual desire in each cycle phase was higher than mean scores for other-directed sexual desire, and the magnitude of the cycle phase effect was greater for partner-directed sexual desire than other-directed sexual desire. These may suggest that women experience sexual desire more strongly towards their partners as Fisher (1998) hypothesized, but romantic love may not completely suppress sexual desire towards other men.

Romantic love/Obsession. The good genes hypothesis predicts that during fertile days partner physical attractiveness is positively associated with partner-directed romantic love, while the attachment bond hypothesis predicts that women's partner-directed romantic love is more intense during fertile days. Contrary to both hypotheses, the main effect of cycle phase on romantic love was not significant, and it was not qualified by partner physical attractiveness or mutual commitment level. This suggests that romantic feelings towards partners remain relatively stable and are unaffected by the cycle phase, levels of partner attractiveness or mutual commitment.

Attachment. Contrary to both the good genes and the attachment bond hypotheses, the main cycle phase effect on attachment (care-receiving, care-giving,

separation distress) was not significant, and it was not qualified by partner physical attractiveness or mutual commitment level. This suggests that partner-oriented attachment is not influenced by the cycle phase, partner attractiveness or mutual commitment.

The Interaction Effect between Sex and Age

Sexual desire. There was a small main effect of respondent age on sexual desire for a partner, with the youngest age ('16-21' year-old') group reporting lower desire than the oldest age ('35+ year-old') group. For partner-directed sexual desire, closer examination revealed that the effect of age was only significant for women, with the youngest group scoring lower than the '22-34 year-old' and the oldest groups, and with the middle group showing the highest level of partner-directed desire. Women's greater partner-directed sexual desire at this age resulted in the absence of a significant sex difference in the '22-34' year groups. One explanation for this finding is that, given that women in this age ('22-34') are at their most fertile, greater partner-directed desire might have evolved in line with this to enhance their reproductive success. Another explanation is that lifestyles in Japan and Occidental countries might be associated with women of this age (e.g., having completed their education) starting to plan for having children, reflected in higher partner-directed desire. In either case, it appeared that women's levels of sexual desire might be more strongly influenced by circumstantial factors (e.g., fertility, environmental context) compared to men.

Romantic love/Obsession. I found no main effect of sex on romantic love ('obsession' in Chapter Four and 'romantic love' in Chapter Five). However, there was a significant but weak interaction between sex and age on romantic love. As with partner-directed sexual desire, the effect of age on romantic love was significant only for women, with women in the middle group ('22-34 year-old') showing the highest level of romantic feelings. If romantic love functions to channel sexual desire to a particular individual (Fisher, 1998), this function might be less relevant to the youngest group (16-21 year-olds who are not prepared to have children) and the oldest group (35 years and older group who are approaching the end of their reproductive life). On the other hand, correlations between romantic love and partner-directed sexual desire showed different patterns across age groups for women, with the correlation being largest for the oldest women. This may imply that, for middle aged women romantic love might have a different function other than focusing their attention to a partner for reproductive purpose.

The Interaction Effect between Culture and Age

Attachment. There was a small to medium main effect of culture on attachment (care-receiving, care-giving, separation distress), in which the Occidental group reported

greater levels of the attachment than the Japanese group. Regarding care-receiving and care-giving (but not separation distress), the effect of culture was qualified by respondent age. Closer examination showed that for the Japanese group the youngest ('16-21 year-old') group showed the lowest mutual attachment (care-receiving and care-giving), whereas for the Occidental group the oldest ('35 or more') group reported the lowest levels. One explanation for this finding is that the younger Japanese might have been more closely connected to their natal family group, resulting in lower mutual commitment in pair-bond relationships. On the other hand, separation distress did not show a significant interaction between culture and with age. This might be due to qualitative differences between mutual commitment components (care-receiving and care-giving) and separation distress, where mutual commitment may be more behavioural and separation distress may be more psychological and context-dependent.

The Interaction Effect between Culture and Relationship Stage

Sexual desire. There was also a small interaction effect between culture and relationship stage on the two types of sexual desire. For other-directed sexual desire, the effect of relationship stage was significant only for the Occidental group. The level of desire towards extra-pair partners was highest at the one-sided love stage, implying that mutual commitment may play an important role in the development of a more exclusive relationship. However, the lack of a significant effect of relationship stage for the Japanese group suggests that mutually committed relationships do not influence the level of sexual desire towards extra-sexual partners for Japanese. This finding may be attributable to cultural differences in the masculinity- femininity dimension, in which sexual experiences are viewed as "a way of performing" in masculine societies whereas they are viewed as "a way of relating" in feminine societies (Hofstede, 2001, p. 328). Regarding partner-directed sexual desire, the effect of relationship stage was only significant for the Japanese group. The level of desire towards partners rose with the progress of relationship stage, but dropped after the birth of children. In Japan, the arrival of children may shift one's social role within a familial context, resulting in viewing the pair-bond relationship as less 'sexual' after having children. The effect of relationship stage on sexual desire showed different patterns across the cultural groups, and this might be due to a cultural difference in how individuals perceive the association between sexual and romantic feelings.

The Interaction Effect between Sex and Culture

Sexual desire. Men showed stronger sexual desire (both partner-directed and other-directed) than women across Japan and Occidental countries, but the effect interacted with culture. Partner-directed sexual desire was expected to be less intense in

Japan than in Occidental countries due to the cultural characteristics of collectivism in Japan (i.e., diffused intimacy between other social members) and masculinity in Japan (i.e., less focused attention on relationships). As expected, the Occidental group reported stronger partner-directed sexual desire than the Japanese group. However, the Japanese group reported higher other-directed sexual desire than the Occidental group. Closer examination revealed that Japanese men experienced stronger other-directed sexual desire than Occidental men. The cultural dimension theory (Hofstede, 1998) assumes the gap in gender roles is wider in more masculine societies, where gender roles are more pronounced. This suggests that the cultural value placed on masculinity might have enhanced the conventional sex role division in Japan, resulting in Japanese men showing higher sexual motivation for short-term mating than Occidental men. Furthermore, in support of the cultural dimension theory, the magnitude of sex differences in partner- and other-directed sexual desire was larger in the Japanese than the Occidental groups. These findings suggested that cultural effects may be the one of key factors which affects the degree of sex role divergence.

Conclusions

This section will discuss to which extent the findings of the thesis support the evolutionary perspective on pair-bond relationships.

Fisher's Hypothesis

Fisher (1998) hypothesized that romantic love, sexual desire, and adult attachment were evolved mechanisms functioning to initiate, direct and maintain pair-bond relationships. In the current factor analytic study (Chapter Three), the dimensions of pair-bond relationship were split into six factors: two factors for sexual desire (partner-directed and other-directed desire); a single factor for romantic love (obsession); and three factors for adult attachment (care-receiving, care-giving, separation distress). Fisher proposed that sexual desire motivates individuals to seek sexual union with conspecific members while romantic love leads individuals to prefer a particular mating partner. Thus, the emergence of other-directed sexual desire, partner-directed sexual desire, and romantic love (i.e., obsession) as distinct factors did not contradict her hypothesis. However, the current factor analytic study also yielded three distinct factors for adult attachment (care-receiving, care-giving, separation distress), which was not expected from her hypothesis. Furthermore, when demographic characteristics were controlled between Japan and Occidental samples, the relationship dimensions were shown to be structurally invariant across the two groups. This supported the suggestion that these pair-bond relationship mechanisms are a human universal partners (Buss, 2006; Fisher, 1998; Frank, 1988; Hirshleifer, 1987). However, the associations found for the sexual

desire dimensions suggested that attachment might enhance the exclusivity of pair-bond relationships for Occidentals, whereas it did not decrease sexual desire towards extra-pair partners for Japanese. Although humans may share mechanisms to support pair-bond relationships, these mechanisms may not necessarily or everywhere function to maintain sexually monogamous relationships. Similarly, the study of the female cycle phase effect suggested that women may experience a non-specific increase in sexual desire during fertile days (Roney, 2009). This suggests the need to reconsider the functions of romantic love and attachment, especially in channelling sexual desire.

Moreover, Fisher's hypothesis (1998) suggests that the arrival of children strengthens attachment bonds to support the couple as they undertake parental duties. However, there was no significant association between attachment and parenthood. This may imply that the functions of attachment are not limited to securing bi-parental care to increase offspring survival. In fact, some have pointed out that paternal care does not necessarily increase offspring fitness (Geary, 1998; Sear & Mace, 2008), suggesting that multiple factors (e.g., food guarding, Wrangham, Jones, Laden, Pilbeam, & Conklin-Brittain, 1999) might have contributed to the evolution of pair-bonding.

Sexual Strategies Theory

Sexual strategies theory proposes that humans (both men and women) have evolved distinct short- and long-term mating strategies to solve various reproductive problems (Buss & Schmitt, 1993). Selection should favour individuals that maximises the ratio of benefits to costs. Therefore, individual circumstances are likely to influence strategic mating decisions (Buss & Schmitt, 1993; Buss, 2002). In relation to the relationship dimensions, partner-directed romantic love, attachment, and sexual desire (parental and pair-bond mating effort) were taken to represent a long-term mating strategy, while other-directed sexual desire was representative of a short-term mating strategy. Although life history theory suggests that individuals often face a trade-off between mating and parental efforts (reviewed in Kaplan & Gangestad, 2005), the findings of the present studies suggested that individuals may be able to use both mating strategies flexibly rather than commit themselves to one or the other. The study of personality traits and mating patterns showed that the General Factor of Personality (GFP) supports long-term mating whereas Dark Triad (DT) facilitates short-term mating. However, GFP and DT were shown to be orthogonal traits, implying that these mating strategies are not mutually exclusive alternatives (Buss & Schmitt, 1993) and that the psychological infrastructure for both strategies can co-exist in an individual. This supported Sexual Strategies Theory that proposes one can use both strategies conditionally, depending on individual circumstances. These findings suggest the need to reconsider and further investigate the trade-offs between mating and parental effort. It

also raises questions about the lifetime and circumstantial plasticity of reproductive strategy, and warns against assumptions of a simple one-to-one correspondence between personality type and strategy.

Conventional Sex Role Perspective

The conventional sex role view predicts that males should invest more mating effort (i.e., sexual desire) than females while females should focus more on parental effort (i.e., attachment) than males (e.g., Trivers, 1972). In support of this, men consistently showed higher sexual desire for a partner and for others than women. On the other hand, there was no main effect of sex in emotional aspects of the pair-bond relationship dimensions (romantic love and attachment). This may imply that men indeed have higher motivations to engage in short-term relationships than women, but motivations to initiate and form long-term relationships do not appear to differ between sexes. This tends to support the hypothesis that humans have evolved a reproductive strategy that involves paternal as well as maternal care (e.g., Eastwick, 2009; Fisher, 1989; Lovejoy, 1981; Stewart-Williams & Thomas, 2013). These findings support suggestions that men's propensity to focus more on mating than parental efforts is not as strong as the classic view predicts (Stiver & Alonzo, 2009). In terms of personality traits, a sex difference was not found in GFP or DT. These findings support suggestions that men and women are more alike than different in psychological traits (Hyde, 2005; Stewart-Williams & Thomas, 2013). It has been proposed that humans (both men and women) have evolved mutual mate choice, especially in the context of long-term relationships with the result that the magnitude of psychological sex difference is relatively small (Stewart-Williams, 2013). Recent theoretical developments have noted that the relative choosiness and competitiveness of the two sexes are determined by various factors beyond parental investment, including sex-specific breeding and mortality costs, and mate quality (Kokko & Monaghan, 2001). Seemingly 'role-reversed' patterns such as male parental care, male choosiness, female-female competition, and female short-term mating strategies can evolve under different conditions (Edward & Chapman, 2011; Kokko & Jennions, 2008). In the present thesis, one of the most important factors which affected the sex role divergence was culture, which interacted with sex in sexual desire. The conventional sex roles for men were enhanced in Japan, with Japanese men showing stronger interest in short-term mating than Occidental men. In future studies individual and contextual factors, especially cultural factors, should be investigated to deepen our understanding of human sex role divisions.

Limitations and Future Directions

There are several limitations to the conclusions. First, the current thesis tested the effect of temporal factors (age and relationship stage) by collecting cross-sectional

data from individuals from various backgrounds. However, this method cannot directly test whether relationship dimensions fluctuate with age and/or over the course of relationships. Longitudinal research could clarify the effect of temporal variables on the dynamics of pair-bond relationships. Second, the present studies collected data from individuals in romantic relationships but did not include data from both members of the couple. In order to gain a deeper insight into pair-bond relationships, which are intrinsically inter-dependent, such data would be required. Third, it was shown that culture had a major impact on pair-bond relationship dimensions. It must be acknowledged that some would argue for the possibility that genetic effects underlie these population differences (Rushton, 1992). However, Rushton argued that Oriental populations have been subject to stronger K-selection and directly contrary to his proposal, Occidental participants demonstrated higher levels of attachment and lower levels of sexual desire than Japanese participants. In addition, evolutionary biologists now reject the *r/K* selection framework due to its internal inconsistencies, and prefer life history frameworks based on mortality schedules. Fourth, some of the significant differences that were found may have arisen from age-related, sex-related and cultural differences in willingness to self-disclose, especially on sensitive or personal matters. For example, cultural dimension theory argues that women are expected to be less sexually active in more masculine societies (Hofstede, 1998). Hence, it is possible that Japanese women were less willing to acknowledge their own sexual motivations, and thus scored lower on sexual desire than Occidental women. It is not easy to identify the specific factors (e.g., values, history, religion, economic systems) that underlie cultural differences in human relationships. However, the strong cultural influence found on the relationship dimensions suggests that this should not be ignored by evolutionary psychologists. One of the interests of the thesis was to test how well the evolutionary theories developed in Western cultures fit data from non-Western cultures. The cultural differences found in the pair-bond mechanisms suggest the possibility of cultural bias in these theories. In future studies, ideally one should include a wider range of cultural regions to refine the theory.

The current thesis attempted to improve the quality of data by examining a wider range of relationship-relevant dimensions, by including individuals from various demographic backgrounds (sex, age, relationship stage, culture) and by using more accurate measures and methods (e.g., confirmatory factor analysis to check factor structures across cultures, using daily data from a complete menstrual cycle, using urinary tests to accurately identify ovulation timing). It showed support for the basic premises of evolutionary psychology regarding sex differences in sexual desire but also suggested that the classic view of sex roles may have exaggerated the magnitude of sex differences in pair-bonding mechanisms and minimised the importance of cultural factors.

Appendix A

Relationship Questionnaire

About Our Study

This is an international research project exploring romantic love, adult attachment and sexual desire carried by Durham University. We will ask you to answer some questions about the person whom you are (or were) in love with.

Your involvement is voluntary. The questionnaire will only take about 10 minutes to finish. If you are aged 18 or over, we invite you to take part. You may withdraw from the questionnaire at any point (please close the browser), and in this case your data will not be included in the study.

All data collected for this study will only be used for academic purpose, and the data will be kept full confidential. The study might be published in the future, but if it is published, you will not be identifiable. To ensure anonymity, you do not even have to provide your name.

A project leader: Rei Shimoda
Supervisors: Prof Campbell and Prof Barton
Durham University
Email:----------

If you are willing to take parting the study, please press 'Continue'. If not, please press 'Withdraw'.

How to answer our questionnaire.

*Please think about the person whom you are currently dating or married to. If you are in relationship with several individuals, please think about the person for whom you have the strongest feelings.

*If you are currently not in a relationship, you may think about:
- The person with whom you are currently in love but separated from him/her
- The person with whom you are currently in love but he/she does not know about your feelings for him/her
- The person whom you loved the most in the past.

*If you have never been in love, please imagine how you would feel if you are now in love with somebody.

Please try to get a strong image of that person and your feelings about him/her in your mind. There is no right or wrong answer. Please answer as honestly as possible.

Who is the person you are thinking about?
- Someone I am or was in love with
- Someone I am imagining

1. How old are you?

2. If you are thinking about a person you were in love in the past, how old were you at that time?

3a. What is your sex?
- Male
- Female

3b. If you are female, have you reached your menopause?
- Yes
- No

4. Would you describe yourself as: heterosexual/homosexual/bisexual?
- Heterosexual
- Homosexual
- Bisexual

5. How would you describe your cultural or ethnic background?

- United Kingdom
- China
- Japan
- Europe
- North America
- South America
- Middle East
- South Asia (e.g. India, Pakistan)
- Africa
- Oceania (e.g. Australia, New Zealand, Pacific Islands)
- Others

6a. What is your relationship status with this person? Please check one of alternatives.

- Dating
- Engaged
- Married
- Separated/ Divorced
- Separated by death
- Not in a relationship/One-side love

6b. If you are married, is it an arranged marriage?

- Yes
- No

7. How long have you been (or were you) in a relationship with this person? Please count from the day you first met (If you have not had a relationship with this person, how long have/did you love him or her?).
e.g., If it is 3 years and 2 months: (3) year(s) (2) month(s) ( ) week(s)

- ( ) year(s) ( ) month(s) ( ) week(s)

8. Do you (or did) you have a sexual relationship with this person at any point in your relationship?

- Yes
- No

9. Do you (or did) you live with this person?

- Yes
- No

10. How often are you (or were you) in contact with this person (e.g. calling, emailing, meeting)?

- Every day
- Every week
- Every month
- Every year
- Never

11a. Do you have a child/children with this person?

- Yes
- No

11b. If 'yes', how old are they? Please write numbers in an appropriate box(es) below.

1st child ( ) years old
2nd child ( ) years old
3th child ( ) years old
4th child ( ) years old
5th child ( ) years old
6th child ( ) years old

*From now on, 'my partner' refers to the person who you are thinking about.

Items 12 to 50: 1 = Disagree strongly; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5= Agree strongly

Items 51 and 59: 1 = Not at all; 2 = Once a month; 3 = Once every two weeks; 4 = Once a week; 5 = Twice a week; 6 = 3 to 4 times a week; 7 = Once a day; 8 = More than once a day

Items 52 and 60: 1 = Not at all; 2 = Once or twice a month; 3 = Once a week; 4 = Twice a week; 5 = 3 to 4 times a week; 6 = Once a day; 7 = A couple of times a day; 8 = Many times a day

Items 53 to 57 and 61 to 65: 1 =No desire; 2 = A little desire; 3 = Some desire;
4 = Strong desire; 5= Very strong desire

Item 58 and 66: 1 = Not at all important; 2 = Somewhat important; 3 = Important;
4 = Very important; 5 = Extremely important

12. I would feel despair if my partner left me.
13. Sometimes I feel I can't control my thoughts; they are obsessively on my partner.
14. I feel happy when I am doing something to make my partner happy.
15. I would rather be with my partner than anyone else.
16. I'd get jealous if I thought my partner was falling in love with someone else.
17. I yearn to know all about my partner.
18. I want my partner – physically, emotionally, mentally.
19. I have an endless appetite for affection from my partner.
20. For me, my partner is the perfect romantic partner.
21. I sense my body responding when my partner touches me.
22. My partner always seems to be on my mind.
23. I want my partner to know me – my thoughts, my fears, and my hopes.
24. I eagerly look for signs indicating my partner's desire for me.
25. I possess a powerful attraction for my partner.
26. I get extremely depressed when things don't go right in my relationship with my partner.
27. My partner helps me feel better when something bad happens to me, or I feel upset.
28. My partner is my primary source of emotional support.
29. I feel that my partner understands me when I have a hard time.
30. I would like to be with my partner when I feel sad.
31. I can count on my partner, and I think my partner will always be there for me and care about me in times of need.
32. My partner is whom I would count on for advice when something bad happens to me or I feel upset.
33. I know that my partner senses when I have a problem and will support me.
34. If I achieved something good, my partner is the person I would tell first.
35. I help my partner to feel better when something bad happens to him/her, or he/she feels upset.
36. I believe I am my partner's primary source of emotional support.
37. I try to understand my partner when he/she has a hard time.
38. I would like to be with my partner when he/she feels sad.

39. I am prepared to be counted on by my partner, and I will always be there for and care about my partner in times of need.
40. I would like my partner to count on me for advice when something bad happens to her/him or she/he feels upset.
41. I try to sense if there is a problem with my partner and am willing to support her/him.
42. If my partner achieved something good, I would like to be the first person that he/she would tell.
43. I like to see or talk with my partner regularly.
44. I like to be with my partner if possible.
45. My partner is the person whom I most like to spend time with.
46. I do not like to be away from my partner.
47. If I were separated from my partner, I would feel down or lonely.
48. I would miss my partner if she/he was away.
49. My life would be severely disrupted if my partner was no longer a part of it.
50. If my partner was no longer accessible to me, I would feel greatly distressed.
51. In a typical month, how often would you have liked to engage in sexual activity with your partner?
52. In a typical month, how often have you had sexual thoughts involving your partner?
53. When you have sexual thoughts how strong is your desire to engage in sexual behaviour with your partner?
54. When you see your partner, how strong is your sexual desire?
55. When you spend time with your partner (for example, at work or school), how strong is your sexual desire?
56. When you are in romantic situations with your partner (such as a candle-lit dinner, a walk on the beach, etc.) how strong is your sexual desire?
57. How strong is your desire to engage in sexual activity with your partner?
58. How important is it for you to fulfill your sexual desire through activity with your partner?

Now we will ask you about a person you find attractive (not your partner).

59. In a typical month, how often would you have liked to engage in sexual activity with a person you find attractive (not your partner)?
60. In a typical month, how often have you had sexual thoughts involving a person you find attractive (not your partner)?
61. When you have sexual thoughts, how strong is your desire to engage in sexual behaviour with a person you find attractive (not your partner)?

62. When you first see a person you find attractive (not your partner), how strong is your sexual desire?
63. When you spend time with a person you find attractive (not your partner) (for example, at work or school), how strong is your sexual desire?
64. When you are in romantic situations with a person you find attractive (not your partner) (such as a candle-lit dinner, a walk on the beach, etc.) how strong is your sexual desire?
65. How strong is your desire to engage in sexual activity with a person you find attractive (not your partner)?
66. How important is it for you to fulfill your sexual desire through activity with a person you find attractive (not your partner)?

That is the end of the questionnaire. Thank you for your participation.

Appendix B

The Proportions (%) of Sex, Age, Relationship Length, and Relationship Status in the Japanese and the Occidental Groups Before and After Removing Outliers

	Before (%)		After (%)	
	Japan	Occident	Japan	Occident
Sex				
Male	34.15	26.97	33.95	27.96
Female	65.85	73.03	66.05	72.04
Age				
10s	25.30	26.06	25.31	26.64
20s	39.94	39.39	39.81	39.80
30s	12.80	11.82	12.65	11.84
40s	9.45	9.70	9.57	9.21
50s	8.84	8.79	8.95	7.89
over 60s	3.66	4.24	3.70	4.61
Relationship length				
Less than 3 months	10.98	8.18	10.80	7.89
3 to 6 months	8.54	10.00	8.64	9.21
6 months to 1 year	14.33	15.15	14.20	15.46
1 to 3 years	28.05	27.58	27.78	28.62
3 to 5 years	10.37	12.12	10.49	12.17
5 to 10 years	8.23	9.70	8.33	9.54
10 years or more	18.29	16.06	18.52	15.79
Relationship status				
Dating	39.02	38.18	38.89	40.13
Engaged or married	24.70	26.97	25.00	26.97
Previous relationship	15.24	13.94	15.43	13.49
Separated by death	0.30	0.91	0.31	0.99
One-sided love	20.73	20.00	20.37	18.42

Appendix C

Preliminary Analyses

English-speaking group: Factor analyses

A series of principle axis factor analysis (PAF) and confirmatory factor analysis (CFA) were conducted on the English-speaking group (United Kingdom = 315, North America = 16, Oceania = 1). There were 257 females and 75 males aged between 16 and 83 years old (M = 31.72, SD = 14.78 with 95% CI [30.13, 33.32]). The data were screened for univariate outliers, and 12 cases were removed which produced a final sample size of 320.

Principle axis factor analysis. First, PAF was used to identify underlying factor structures of pair-bond relationships for the observed dataset. In the initial analysis, 52 variables were entered after removing the items (61, 63, and 64) each of which was highly correlated (r > .80) with one or more other items. The case-to-variable ratio was above six to one which reached the minimum level to proceed with the factor analysis. The communalities were all above .35 (M = .56). The Kaiser-Myer-Olkin (KMO) measure was .92 which exceeded the acceptable limit (i.e., > .05), demonstrating very good sampling adequacy (Hutcheson & Sofroniou, 1999). Bartlett's test of sphericity was significant, χ^2 (1326) = 9726.43, p < .001, which showed that the correlation matrix was not an identity matrix. These tests together showed that the data were appropriate for factor analysis. PAF was repeated according to the analysis criteria (1), (2), and (3). During the analytic iterations, 15 items were dropped for the following reasons: loading on one or more factors (items 13, 22, and 26), failing to meet the >.40 loading criterion (items14, 16, 18, 20, 21, 23, 24, 25, 30, 34, 43, and 48), and improvement of internal consistency (item 59).

For the final analysis, the remaining 37 variables were entered. The KMO measure (= .91) passed the acceptable limit. Bartlett's test of sphericity was significant, χ^2 (666) =6698.45, p < .001. The communalities were all above .35 (M = .56). Six factors had eigen values above Kaiser's criterion of one, and together explained 62.62% the variance. The six-factor solution was also confirmed by the scree test and the parallel analysis (O'Connor, 2000). Given the large sample size and average of the communalities, the six-factor solution suggested by Kaiser's criterion was acceptable. Considering these factor extraction criteria together, six factors were retained in the final solution and presented in Table 1. Factor 1 explained 27.26% of variance, 14.43% was explained by factor 2, 7.54% by factor 3, 6.16% by factor 4, 3.88% by factor 5, and 3.35% by factor 6.

Table 1

Factor Loadings for the (Pre-)Final Solution of PAF for the English-Speaking Group*

Items from each of six relationship dimensions scales and their sub-dimensions in brackets.	Factors					
	1	2	3	4	5	6
57 Sexual desire for a partner (Intensity)	.87					
54 Sexual desire for a partner (Intensity)	.84					
52 Sexual desire for a partner (Frequency)	.80					
51 Sexual desire for a partner (Frequency)	.75					
56 Sexual desire for a partner (Intensity)	.74					
55 Sexual desire for a partner (Intensity)	.73					
53 Sexual desire for a partner (Intensity)	.71					
58 Sexual desire for a partner (Intensity)	.61					
32 Attachment (Care-receiving/secure base)		.82				
27 Attachment (Care-receiving/safe haven)		.78				
29 Attachment (Care-receiving/safe haven)		.78				
31 Attachment (Care-receiving/secure base)		.76				
33 Attachment (Care-receiving/secure base)		.71				
28 Attachment (Care-receiving/safe haven)		.70				
36 Attachment (Care-giving/safe haven)		.53				
65 Sexual desire for others (Intensity)			.90			
62 Sexual desire for others (Intensity)			.83			
60 Sexual desire for others (Frequency)			.79			
59 Sexual desire for others (Frequency)			.75			
66 Sexual desire for others (Intensity)			.64			
17 Romantic love (Desire to know the partner and to be known)				.62		
15 Romantic love (Idealization of the partner or of the relationship)				.61		
45 Attachment (Proximity seeking)				.56		
44 Attachment (Proximity seeking)				.56		
42 Attachment (Care-giving/secure base)				.55		
46 Attachment (Separation distress)				.49		
19 Romantic love (Longing for reciprocity)				.47		
40 Attachment (Care-giving/secure base)					.67	
38 Attachment (Care-giving/safe haven)					.66	
41 Attachment (Care-giving/secure base)					.63	
37 Attachment (Care-giving/safe haven)					.56	
39 Attachment (Care-giving/secure base)					.52	
35 Attachment (Care-giving/safe haven)					.50	
49 Attachment (Separation distress)						.75
12 Romantic love (Negative feelings when things go awry)						.74
50 Attachment (Separation distress)						.74
47 Attachment (Separation distress)						.65

Note. * Only loadings > .40 are reported.

Confirmatory factor analysis. CFA diagnostics were consulted to see if the model fit could be improved. A six-factor structure (allowing for correlated factors) was specified with a total of 37 variables: factor 1 (8 items); factor 2 (7 items); factor 3 (5 items); factor 4 (7 items); factor 5 (6 items); and factor 6 (4 items). A case-to-variable ratio was above eight to one which passed the acceptable limits to proceed with CFA. The chi-square test showed that the model and the actual data were significantly different, χ^2 (614) = 1124.09, $p < .001$, but in large samples the chi-square test inclines to reject any model as insufficient (Bentler & Bonett, 1980). CFI (= .92) and RMSEA (= .05 with 90% CI [.05, .06]) exceeded the .90 and .05 thresholds, respectively. However, GFI (= .84) did not reach the .90 threshold. The fit indices together indicated that the model needed further improvement.

CFA (and PAF) were repeated according to the analysis criteria (4) and (5). During iteration of the analyses, items were dropped because modification indices suggested their deletion would improve the model fit. The following items were dropped: Items 51, 52, 55, and 58 (from the factor 1); 28, 31, and 36 (from factor 2); 66 (from factor 3); and 46 (from factor 4). In the final solution of CFA, although the chi-square test was still significant, χ^2 (335) = 529.36, $p < .001$, the other fit indices indicated that the model fit was good, GFI = .90, CFI = .96, and RMSEA= .04 with 90% CI [.04, .05].

PAF was re-run with the remaining 28 items. The KMO measure (= .90) passed the acceptable limit. Bartlett's test of sphericity was significant, χ^2 (378) = 4520.69, $p < .001$. The communalities were all above .31 (M = .57). A six-factor solution was suggested by by Kaiser's criterion, the scree test, and the parallel analysis (O'Connor, 2000). Thus, six factors were retained. Table 2 shows the pattern matrix from the final solution. The six factors together explained 65.44% of the variance, an improvement on the previous PFA (62.62%). Given the nature of the items loadings, the following names were given to the factors (with associated percentages of variances explained): *sexual desire for a partner* (29.89 %); *adult attachment/care-giving* (11.75 %); *sexual desire for others* (8.38 %**)**; *adult attachment/care-receiving* (6.76 %); *seeking proximity and emotional connection* (4.62 %); and *separation distress* (4.04 %).

Table 2

Factor Loadings for the Final Solution of PAF for the English-Speaking Group after Measurement Refinement by CFA

Items from each of six relationship dimensions scales and their sub-dimensions in brackets.	Factors					
	1	2	3	4	5	6
57 Sexual desire for a partner (Intensity)	.89					
54 Sexual desire for a partner (Intensity)	.87					
56 Sexual desire for a partner (Intensity)	.74					
53 Sexual desire for a partner (Intensity)	.72					
38 Attachment (Care-giving/safe haven)		.73				
40 Attachment (Care-giving/secure base)		.67				
41 Attachment (Care-giving/secure base)		.67				
37 Attachment (Care-giving/safe haven)		.57				
39 Attachment (Care-giving/secure base)		.56				
35 Attachment (Care-giving/safe haven)		.55				
65 Sexual desire for others (Intensity)			.86			
62 Sexual desire for others (Intensity)			.83			
60 Sexual desire for others (Frequency)			.82			
59 Sexual desire for others (Frequency)			.75			
29 Attachment (Care-receiving/safe haven)				.85		
32 Attachment (Care-receiving/secure base)				.74		
27 Attachment (Care-receiving/safe haven)				.72		
33 Attachment (Care-receiving/secure base)				.69		
15 Romantic love (Idealization of the partner or of the relationship)					.68	
45 Attachment (Proximity seeking)					.66	
17 Romantic love (Desire to know the partner and to be known)					.59	
44 Attachment (Proximity seeking)					.58	
42 Attachment (Care-giving/secure base)					.54	
19 Romantic love (Longing for reciprocity)					.50	
12 Romantic love (Negative feelings when things go awry)						.82
49 Attachment (Separation distress)						.78
50 Attachment (Separation distress)						.76
47 Attachment (Separation distress)						.60

Note. Factor 1 was labelled as sexual desire for a partner, factor 2 as adult attachment/care-giving, factor 3 as sexual desire for others, factor 4 as adult attachment/care-receiving, factor 5 as seeking proximity and emotional connection, factor 6 as separation distress.

Application of the Model to the Occidental Group

The European participants (n = 190) were added to the English-speaking group in order to make up the Occidental group, and CFA tested how well the model identified in the previous analysis fit to the new dataset. After combining the two groups, there were 401 females and 121 males aged between 16 and 83 years old (M = 29.90, SD = 13.11 with 95% CI [28.78, 31.03]). The data were screened for univariate outliers, and 21 cases

were removed which produced a final sample size of 501 (United Kingdom = 300, Europe = 185; North America = 15, and Oceania = 1).

Confirmatory factor analysis. The chi-square test showed that the model and the actual data were significantly different, χ^2 (335) = 598.82, $p < .001$, but in large samples the chi-square test inclines to reject any model as insufficient (Bentler & Bonett, 1980). GFI (= .92) and CFI (= .96) were above the .90 threshold (GFI = .92; CFI = .96). RMSEA also exceeds the .05 threshold (= .04 with 90% CI [.04, .05]). These indices indicated that the model identified from the English-speaking group fitted well to the Occidental group. Thus, the European participants were added to the English-speaking participants to increase the sample size.

Appendix D

Relationship Dimension Scales

Scale	Item
Obsession	- I have an endless appetite for affection from my partner. - I yearn to know all about my partner. - My partner always seems to be on my mind. - I eagerly look for signs indicating my partner's desire for me.
Care-receiving	- My partner helps me feel better when something bad happens to me, or I feel upset. - I feel that my partner understands me when I have a hard time. - I can count on my partner, and I think my partner will always be there for me and care about me in times of need. - I know that my partner senses when I have a problem and will support me.
Care-giving	- I help my partner to feel better when something bad happens to him/her, or he/she feels upset. - I try to understand my partner when he/she has a hard time. - I would like to be with my partner when he/she feels sad. - I try to sense if there is a problem with my partner and am willing to support her/him.
Separation distress	- I would feel despair if my partner left me. - If I were separated from my partner, I would feel down or lonely. - My life would be severely disrupted if my partner was no longer a part of it. - If my partner was no longer accessible to me, I would feel greatly distressed.
Sexual desire for a partner	- When you see your partner, how strong is your sexual desire? - How strong is your desire to engage in sexual activity with your partner? - How important is it for you to fulfill your sexual desire through activity with your partner?
Sexual desire for others	- When you first see a person you find attractive (not your partner), how strong is your sexual desire? - How strong is your desire to engage in sexual activity with a person you find attractive (not your partner)?

Appendix E

Relationship Dimension Scales

Scale	Item
Romantic love	- Sometimes I feel I can't control my thoughts; they are obsessively on my partner. - I yearn to know all about my partner. - For me, my partner is the perfect romantic partner. - I want my partner to know me – my thoughts, my fears, and my hopes. - I get extremely depressed when things don't go right in my relationship with my partner.
Adult attachment	- My partner is my primary source of emotional support. - I know that my partner senses when I have a problem and will support me. - I would like to be with my partner when he/she feels sad. - If my partner achieved something good, I would like to be the first person that he/she would tell. - My partner is the person who I most like to spend time with. - If I were separated from my partner, I would feel down or lonely.
Sexual desire for a partner	- In a typical month, how often would you have liked to engage in sexual activity with your partner? - How strong is your desire to engage in sexual activity with your partner?
Sexual desire for others	- In a typical month, how often would you have liked to engage in sexual activity with a person you find attractive (not your partner)? - How strong is your desire to engage in sexual activity with a person you find attractive (not your partner)?

Appendix F

General Factor of Personality Scale (Big Five Inventory-10)

I see myself as someone who...

Scale	Item
Extraversion	…is reserved. (R)
	…is outgoing sociable.
Agreeableness	…tends to find fault with others. (R)
	…is generally trusting.
	…is considerate and kind.
Conscientiousness	…tends to be lazy. (R)
	…does a thorough job.
Neuroticism (emotional stability)	…is relaxed, handles stress well.
	…gets nervous easily. (R)
Openness	…has few artistic interests.
	…has an active imagination.

Note. Big Five Inventory-10 (Rammstedt & John, 2007). R = items were reversed-scored.

Appendix G

Dark Triad Scale (Dirty Dozen scale)

Scale	Item
Machiavellianism	I tend to manipulate others to get my way.
	I have used deceit or lied to get my way.
	I have used flattery to get my way.
	I tend to exploit others towards my own end.
Psychopathy	I tend to lack remorse.
	I tend to be unconcerned with the morality of my actions.
	I tend to be callous or insensitive.
	I tend to be cynical.
Narcissism	I tend to want others to admire me.
	I tend to want others to pay attention to me.
	I tend to seek prestige or status.
	I tend to expect special favours from others.

Note. Dirty Dozen Scale (Jonason & Webster 2010).

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